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HAMBURG AMERICAN TWIN SCREW CRUISING YACHT PRINZESSIN VICTORIA LUISE.

There entered the port of New York on January 17 the beautiful new passenger vessel *Prinzessin Victoria Luise* on her maiden trip from Hamburg, Boulogne and Plymouth. As our engraving shows this vessel is designed as a pleasure yacht, with clipper bow, long over hang at the stern, two pole masts and two funnels, set rakishly, with bell mouth tops. Her dimensions are: Length, 450 ft.; beam, 47 ft., and depth, 30 ft. She came across at about 15 knot speed, and though she encountered very severe weather, she arrived with everything in A1 condition. As the yacht is intended for passenger service only her accommodations are very luxurious and artistic. Upon the arrival of the vessel at New York invitations for a luncheon on board were issued by the company and a large number of guests were very hospitably entertained. In a future issue we hope to publish a more extensive description of the yacht.

HAMBURG AMERICAN CO.'S TWIN SCREW YACHT PRINZESSIN VICTORIA LUISE.

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SUGGESTIONS FOR THE INTERCHANGEABILITY OF UNITS FOR MARINE WORK.*

BY W. D. FORBES.

No country in the world recognizes the great advantage of interchangeable machine parts as does the United States. There is little doubt that it had its origin here, and its introduction has materially aided in placing the United States in the foremost rank of manufacturing nations.

It is useless to call attention to the great refining influence the system has had in the mechanical field and its effect on the commercial world; yet it is fair to say that no point so strongly recommends the American machinery to the foreign buyer as that of his being able to obtain duplicate parts that actually fit.

If duplicate or interchangeable parts are admitted to be of value, why would not interchangeability of units be equally advantageous? Especially where the mechanical contrivance is to be used on shipboard, as there the slightest alteration or repair costs out of all reason, both in time and money, when compared with the same work done on shore. It is safe to assert that work done aboard ship costs many times more than it does in a shop, owing to the loss of time of the men going to and returning from work and the cramped and crowded quarters in which the work has to be done. Of course, if a pump is worn out, for instance, or is so damaged as to demand its being replaced, one of the same size and make could probably be readily fitted into the old position, yet this is by no means certain.

In most cases work on a ship is done at high pressure, and the result is that it is slighted wherever possible, and breakdowns and trouble follow. It is often the case that a certain mechanical contrivance is too large or too small for the work it has to do, and although the next size larger or smaller may vary but little in size, those in charge of repairs and alterations are loath to make either, on account of the enormous expense arising from the facts above mentioned. It seems to the writer that the Navy is in a position to start a system of interchangeability of units in its auxiliary machinery without in any way making it necessary to use a certain make or style of machine, or without inflicting on the manufacturing public any real burden.

To illustrate the idea, it is proposed that all generating sets, for instance, whether made by one company or another, of the same K. W. output, shall have the base plate holding down bolts in exactly the same position, and the steam inlets and outlets in exactly the same relative positions in vertical and horizontal planes. Figs. 4 and 5.

It does not seem practical, however, to carry out this idea entirely, but it can at least be approximated so that far less work will be required in substituting one size of mechanical contrivances for others, even if of different makes.

It is comparatively little trouble to make changes in piping, as cutting off and threading pipe is not work which demands either great skill or tools which are not to be found on shipboard, and if the holding down bolts or holes are so placed as to need no attention in contemplating or making changes it is evident that the most difficult and annoying part of such work will become simple.

In the commercial world time has fairly well fixed certain designs, and to attempt to get the manufacturers to alter their patterns would hardly be successful; yet new designs are constantly being brought out, and new patterns are required to replace the old ones, and as the proposed alterations do not affect the essential features of any special make, it seems possible to have new patterns and designs meet the demands of the proposed system.

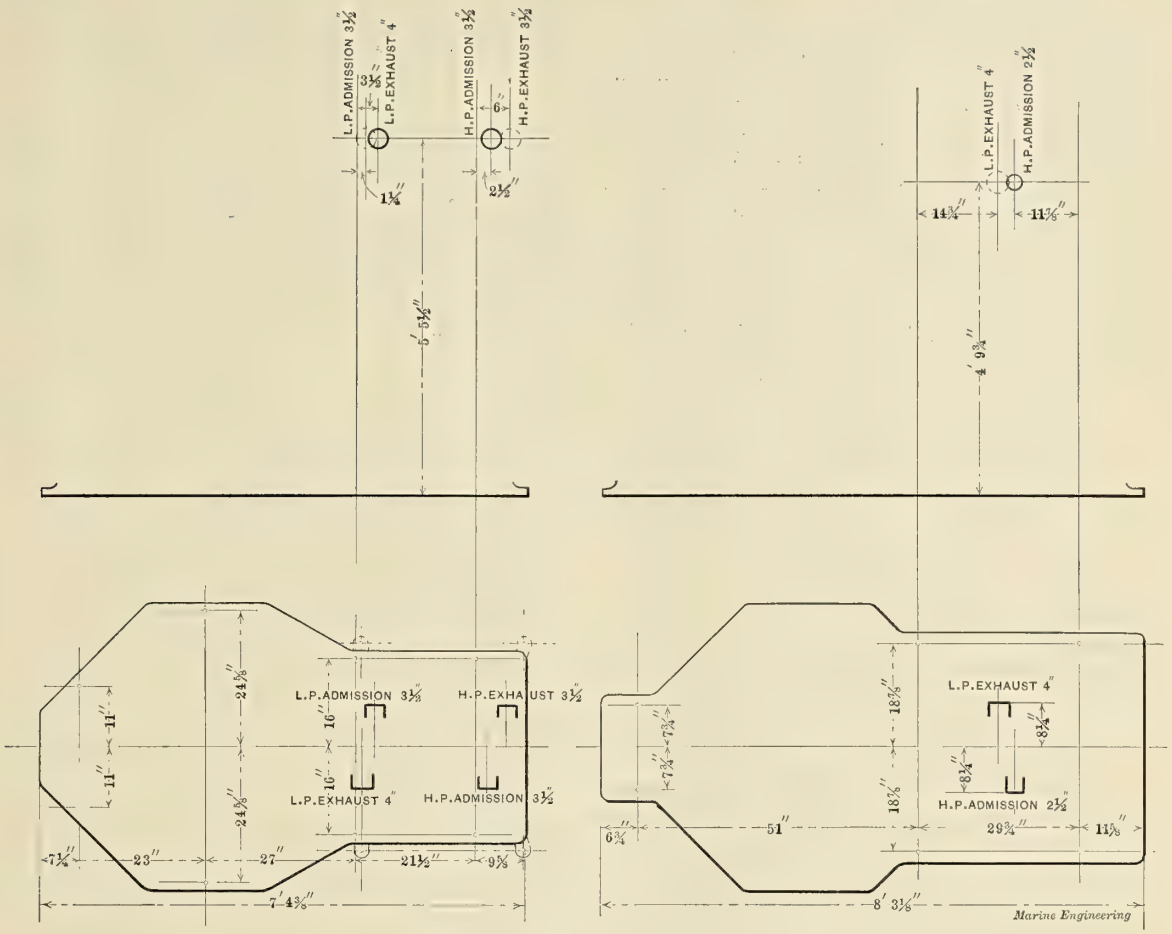
The main difficulty is that at the present moment no standard exists. Judging from the conversation which the writer has had with manufacturers, there would be little difficulty in getting them to fall in line with any system which would produce interchangeability of units.

In the Navy it would seem to the writer quite easy to get this idea carried out, as most Governmental work is specially gotten up, and the slight alterations necessary could be made at comparatively trifling expense. As the Navy now employs a standard flange for steam and water connections of pipe, if the proposed system were adopted, a unit could be readily taken out bodily and replaced with another by simply breaking joints and loosening up on the holding down bolts. The flexibility of wires on electrical apparatus is such as to demand no change whatever. Take, for instance, the duplex pump of the Admiralty pattern, Figs. 1, 2 and 3, of 7 1-2 in. by 5 in. by 6 in., and one of 9 in. by 6 in. by 6 in., it will be found that the steam and exhaust are of the same size, also the suction and discharge. From the face or foot to the holding down feet is respectively 50 7-8 in. and 47 3-4 in., a difference of 3 1-8 in. The bolt holes in the feet are respectively 14 1-2 in. and 14 in. across the pump, and 8 7-8 in. and 7 1-2 in. at right angles, a difference of 1 3-8 in. in one case and 1-2 in. in another. The difference from the center of the cylinder to the face of the feet is 8 1-4 in. Now, the steam and exhaust being the same sizes, no change of piping is required, except in the length of a nipple; by dropping the position of the upper holding lug 3 in. on the large pump, and there is ample room to do this, the feet could be made alike and interchangeable, as the holes are pitched equally.

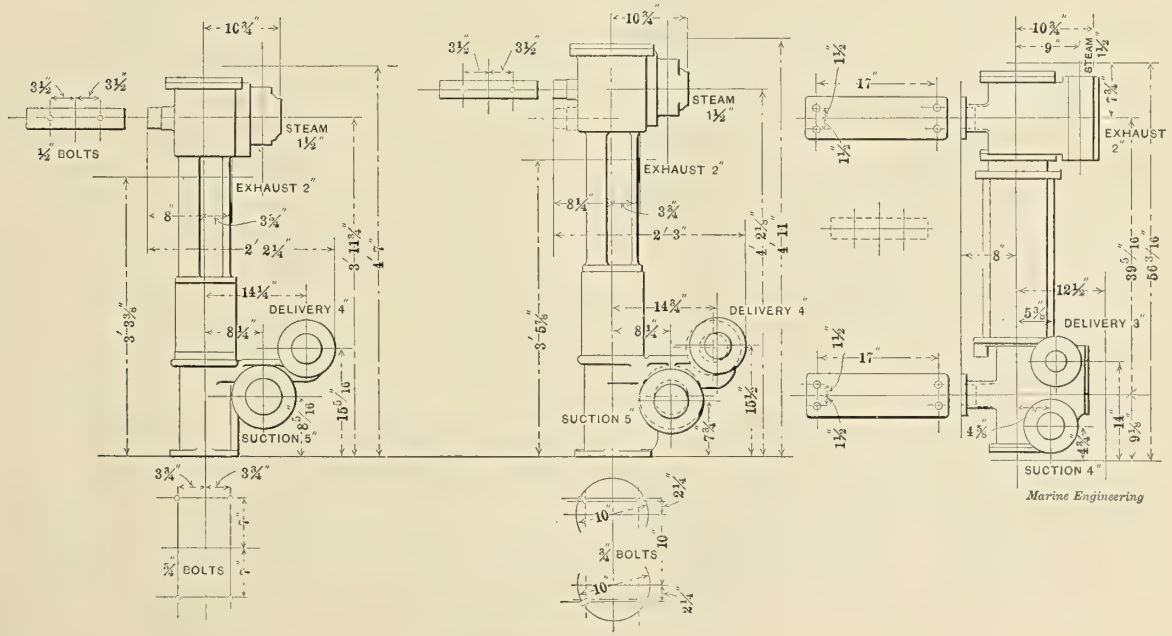
To make the suction and discharge perfectly interchangeable horizontally, one being 14 1-2 in. and the other 14 3-4 in., but a very slight change would be required, but the vertical position of the suction of the large pump would have to be raised 9-16 in. and its discharge lowered 3-16 in. The widest part of each of these pumps, that is, through the valve chamber, differs about 3 in., the depth of the two pumps vary by 3-4 in.; in other words, the pumps are almost interchangeable, and could be made so at a very slight cost and with very insignificant alterations, as noted.

It is very much easier to arrange for interchangeability of electric units in which the holding down system only has to be considered, and also the position of the steam and exhaust. In sets of different makes now being tested in one of our navy yards they could be made interchangeable by simply shifting the hold-

*A paper read at the eighth general meeting of the Society of Naval Architects and Marine Engineers, held in New York.



FORBES PAPER—FIGS. 4 AND 5.



FORBES PAPER—FIGS. 1, 2 AND 3.

ing down lugs but a few inches, and by having one of the makers supply with his engine short nipples and flanges, so as to make the difference from the center of his engine to the faces of the steam and exhaust equal to that of the other. The same idea, of course, could be readily carried out on circulating pumps, blower engines, etc., and it is self-evident that, should the Navy give certain dimensions and positions which must be always met by bidders, the commercial world would be furnished with machines having these dimensions, for reasons that are quite obvious, resulting, the writer feels sure, in materially lessening the annoyances arising from repairs and alterations on shipboard, and in the saving of money.

In some parts of the world interchangeability of entire units is recognized as not only possible but is actually carried out. Small marine engines are so arranged that instead of making repairs in place they are quickly lifted out of the hull and another engine dropped in and at once coupled up.

There is no doubt whatever but what the suggestions of the writer will be looked upon by many as impossible and impracticable; that seems to be the natural tendency on the part of all makers of machinery if any change is suggested; but many members of this Society will no doubt be able to recall that when the idea of shafting and pulleys was proposed, and a commercial engineering firm began the manufacture of stock pulleys, almost all the engineers insisted that a hole could not be made in Philadelphia to fit a shaft made in New York; that the demand for pulleys was so varied as to face, bore, etc., etc., that it would be quite impossible to carry on the pulley business. Again, it is not many years since firms began the manufacture of stock gears, and everybody predicted that it would be useless to attempt to help the commercial world in the matter of transmitting power by gear wheels, but to-day a list of gears is found in every draughting room, and few designers would think of undertaking work without using standard gears.

M. E. B. A. Meeting.—At the annual meeting of the Marine Engineers' Beneficial Association, held in Cleveland last month, the old officers were reelected with one exception only. The new board consists of: President, George Uhler, of Philadelphia; Vice-President, Frank A. Jones, of San Francisco; Secretary, George A. Grubb, of Chicago; Treasurer, A. L. Jones, of Detroit. Members of the advisory board elected were: J. McG. Sterritt, of New York; Joseph Brooks, of Philadelphia, and William Schafer, of Baltimore.

Typhoon at Hong Kong.—Details were received last month by mail of the typhoon which caused great loss of life and delay to shipping at Hong Kong, about the middle of November. The American ship *Benjamin Sewall*, 1,434 gross tons, went ashore, but was subsequently gotten off, though leaking badly. The British warship *Sandpiper* foundered and some of her crew were lost, and the transpacific steamship *Empress of India*, which was lying at her wharf at Klowloon, was badly shaken up. A large dredge, which had recently arrived out from Scotland was capsized, and along the shore enormous damage was done to property.

A BRIEF SKETCH OF THE ORIGIN AND DEVELOPMENT OF THE WORLD'S SHIPPING.

BY LAWRENCE IRWELL.

In considering the development of maritime commerce, it is necessary to remember that the idea of Columbus and the early navigators in sailing westward was not to find America, but to find a new way to India. Great as the United States have become in the world's commerce, their first occupation was only an incident in the struggle for the trade of the far East. But with the occupation of the American continent came two new developments in the carrying-trade, viz., one across the Atlantic, and another across the Pacific. To the eventful year in which many great enterprises were started—1840—we trace the beginning of steam-carrying on the Pacific, for in that year William Wheelright took or sent the first steamer round Cape Horn, as the pioneer of what is now called the Pacific Steam Navigation Co. Within about a dozen years from the time named, there were about fifty American steamers constantly employed upon the Pacific coasts of the two continents. Out of one of these steamship lines grew Commodore Vanderbilt's Nicaragua Transit Co., a double service of two distinct routes, one on each side of the continent, with an overland connection through Nicaragua. Out of another grew the New York and San Francisco route, connecting overland across the Isthmus of Panama. And out of yet another of the Pacific enterprises grew, in the course of years, a line between San Francisco and Hawaii, and another between San Francisco and Australasia. Forty years ago, the ships of the last-named line used to call at Panama to pick up passengers and freight from Europe, and it is interesting to recall that at that time the plan of a regular steamship service between England and Australia, via Panama, was greatly favored. A company was formed for the purpose, but it never owned any ships. As long ago as the early fifties, however, there were more than half a dozen steamship companies, whose ships met at Aspinwall, and there were five on the Pacific whose ships met at Panama. At this period the Panama railroad was under construction; and later, when the road was completed, steamer routes were started from San Francisco to China and Japan, eventually followed by the Canadian Pacific line to China. The last-named British enterprise was inaugurated after the Canadian railroad across the continent had been built.

From the old fruit and grain sellers of the Mediterranean trade have developed such extensive concerns as the Cunard Co. (one of whose beginnings was a service of steamers between Liverpool and Havre), which now covers the whole Mediterranean, and maintains a frequent service from Liverpool to New York and Boston; the Anchor line, which began with two ships sailing between Scotland and Spain or Portugal, and now has steamers from Scotland to this country, as well as to India and elsewhere; the Bibby line, whose beginning was a single ship from Liverpool to Marseilles, and now covers, under the name of the Leyland line, every part of the Mediterranean, in addition to spreading out to the East. These are only a few of many examples of how the carrying trade of the world,

both east and west, has developed in Europe from very modest beginnings; but even now the freight traffic between Great Britain and the Mediterranean is less in the hands of these powerful companies than in the fleets of ocean "tramps."

Of the American steamship business it is not pleasant to write, for the carrying trade to and from this country has seriously declined. In 1860, seventy per cent of the United States export trade was done in ships flying the Stars and Stripes; of the import trade 63.8 per cent. In 1898 (the latest year at hand), the figures respectively were 5.9 and 16. The causes of this decrease, being controversial, are outside the range of this paper.

Perhaps the most remarkable development in the shipping trade of the world is the company called the Messageries Maritimes of France. Prior to the Crimean War (1854-1856), there was a partnership of a number of men known as the Messageries Impériales, which was engaged in the land-carriage of mails through France. In 1850—or the following year—this company entered into a contract with the French Government for the conveyance of mails to Italy, Greece, Egypt and some other countries; and as time went on the mail subsidies became so heavy that the company was practically a national enterprise. During the war, the Messageries' vessels were in such demand as transports, &c., that it was compelled to build a new fleet for mail-carrying purposes with all possible speed. With peace came the difficulty of employing the enormously augmented fleet. New lines of mail and fruit boats were therefore established between France and the Danube and the Black Sea; between Bordeaux and Brazil; between Marseilles and India. The ramifications of the Messageries Co. now extend from France to England; to the whole of South America, the Levant, the Black Sea, the Indian Ocean, China, and the South Pacific.

Few persons have any correct conception of the number of regular lines of steamers now connecting this country and Europe, and South America and Europe. Between the various ports of the United States and the European countries there are about thirty distinct regular steamship companies conveying freight and passengers, and about twelve more which carry freight but no passengers. Four of these are German; two are French; two are Dutch; two Belgian; one Danish, and one Italian. All the rest of the passenger lines, as well as most of the freight lines, "run" (as it is called) between the United Kingdom and the United States, and two of them fly the American flag. As for the "tramps" which steam and sail between North America and Europe, they are of all nations; but the majority are British, though there was a time when the American-built clippers used to monopolize the Atlantic carrying-trade.

The South American trade is represented by the Messageries, the Austro-Hungarian Lloyds, and the Italian mail lines, in addition to nearly a dozen companies whose steamers connect Europe with Brazil and Argentina.

Concerning India, the growth of the shipping business has been enormous since Vasco da Gama, four hundred years ago, found his way round the Cape of Good Hope. For an entire century, down to 1600, the Portuguese monopolized the trade of the East, and as many as two hundred of their ships would often be found in the port of Goa, taking in cargo for different European countries. To-day, Goa (on the west coast of India) is a deserted port, and the Portuguese flag is rarely seen, since half a dozen ships a year are sufficient to do all the business between Portugal and India. During the century of Portuguese prosperity, the British flag was hardly known in Eastern waters. The Dutch, in time, took the place of the Portuguese; and the reason that the Dutch were tempted to go to India was that the rich cargoes brought home by the Portuguese could not be disposed of in Portugal, and had to be taken to Amsterdam or Rotterdam before the merchants of Holland would buy them for re-sale throughout Europe. This is how the Dutch came into direct relations with the Indian trade before the British, and why efforts were made to discover a short road to India for the Dutch ships by way of the north of Europe and Asia. Failing in the north, the Hollanders followed the Portuguese round the Cape, and reaching Sumatra, they founded the wide dominion of Netherlands-India. This occupation was effected before 1600; and between that year and 1670 they expelled the Portuguese from every part of the Eastern Archipelago, from Ceylon, from Malacca, and from the Malabar coast.

The Dutch, in turn, enjoyed a monopoly of the Indian trade for about a hundred years. Their downfall came before the year 1800, and a decade later their possessions in the East had been taken from them. Eventually, they got back Java and Sumatra, both of which now transact a large business with Holland. It should be noticed, however, that this carrying trade is restricted to Dutch vessels. In India, the Netherlands has not a single possession, and it is not probable that that country contains a thousand Dutch residents.

A gigantic trade is done between Europe and India, both through the Suez Canal and by way of the Cape. A great part of the importing and exporting is conducted by the Peninsular and Oriental, the British-India, the Clan, the Anchor, and the City lines of steamers, as well as by the Messageries Maritimes, and North-German Lloyds, and also by the British-India Co. The greater part of the carrying trade between India and Australia, China, Japan, Mauritius, &c., is done by ships flying the red ensign of the British merchant service.

A new shipping business was created when the Australian colonies were founded in the conveyance of machinery, implements, &c., and in bringing back to Europe wool and tallow, and later, gold, wheat, and frozen mutton. This trade is now divided between sailers and steamers, and in the steamer traffic the Germans and Frenchmen are making great efforts to get a share. Another new carrying trade has been brought into existence of recent years by the opening up of South Africa. This is almost all in British hands.

The proportions of the several maritime nations in the international carrying trade cannot be given with absolute accuracy, but the tables published by the British Board of Trade (a department of the govern-

ment) enable one to give a general idea. In 1895, the tonnage of steam and sailing vessels of all nationalities in the foreign trade entering and clearing at ports in Great Britain was about 75,500,000 tons, of which about 55,000,000 tons were British, and 20,500,000 tons were foreign. In the foreign total, the largest proportions were as follows:

Approximate Figures.

	Tons.
Norwegian	5 000 000
German	3 700 000
Dutch	2,000,000
Swedish	1,800 000
Danish	1,700,000
French	1,800 000
United States	464,000

Looking at the part which British shipping plays in the foreign trade of other countries—the part which the Great Republic ought some day to play—we get the following figures, which are as accurate as any such statistics can be expected to be.

Country.	Entrances and Clearances. Tons.	Percentage that was British.
Russia	9,319,806	48.2
Norway	5,775,203	12.7
Sweden	11,446,173	19 1
Germany	22,405,872	36 4
Holland	11,845,875	50.2
France	28,120,524	44.6
Portugal	11,082,049	51.0
Italy	13,943,927	43.6
United States	33,504,271	51.6

Next may be given the total tonnage of the merchant vessels, both steam and sail, belonging to *the* great maritime nation in 1895. These figures include the whole British Empire, and are the net tonnage of the government table, not the gross tonnage of Lloyds' register, which would considerably swell the numbers in every case.

	Tons.
United Kingdom	8.778.503
Canada and Newfoundland	985.759
Australasia	365,058
India and Ceylon	65,413
Other British Possessions	170,834
Total tonnage of British Empire..	10,365.567

It seems well by way of comparison to quote the total tonnage of the merchant navies (steam and sail) of the chief maritime countries of the world. At present, the United States are not taking a proper part in the oversea trade, as all statistics conclusively demonstrate.

Approximate Tonnage of Merchant Vessels.

Country.	Tons.
Russia	500 000
Finland	257.854
Norway	1,744,993
Sweden	548 771
Denmark	318,817
Germany	1,511,579
Holland	292,763
Belgium	70,395
France	905,606
Italy	811,264
Austro-Hungary	196,647
Greece	311,550
United States (oversea trade)	899,803
United States (lake and river trade)	3,925,268

These figures give a total of over twelve million tons.

An important item of international carriage of quite modern development is the mineral oil trade of this country and of Russia. The conveyance of these oils is, of course, a trade by itself. Another special branch of the world's carrying trade is connected with the sea-fisheries. All the fishing-grounds of the Atlantic may be said to be now in touch with the consuming markets by services of steamers. The cod-fisheries off the banks of Newfoundland transfer their dried and salted fish to vessels which take them as far away as France and Italy, as well as to the nearer countries.

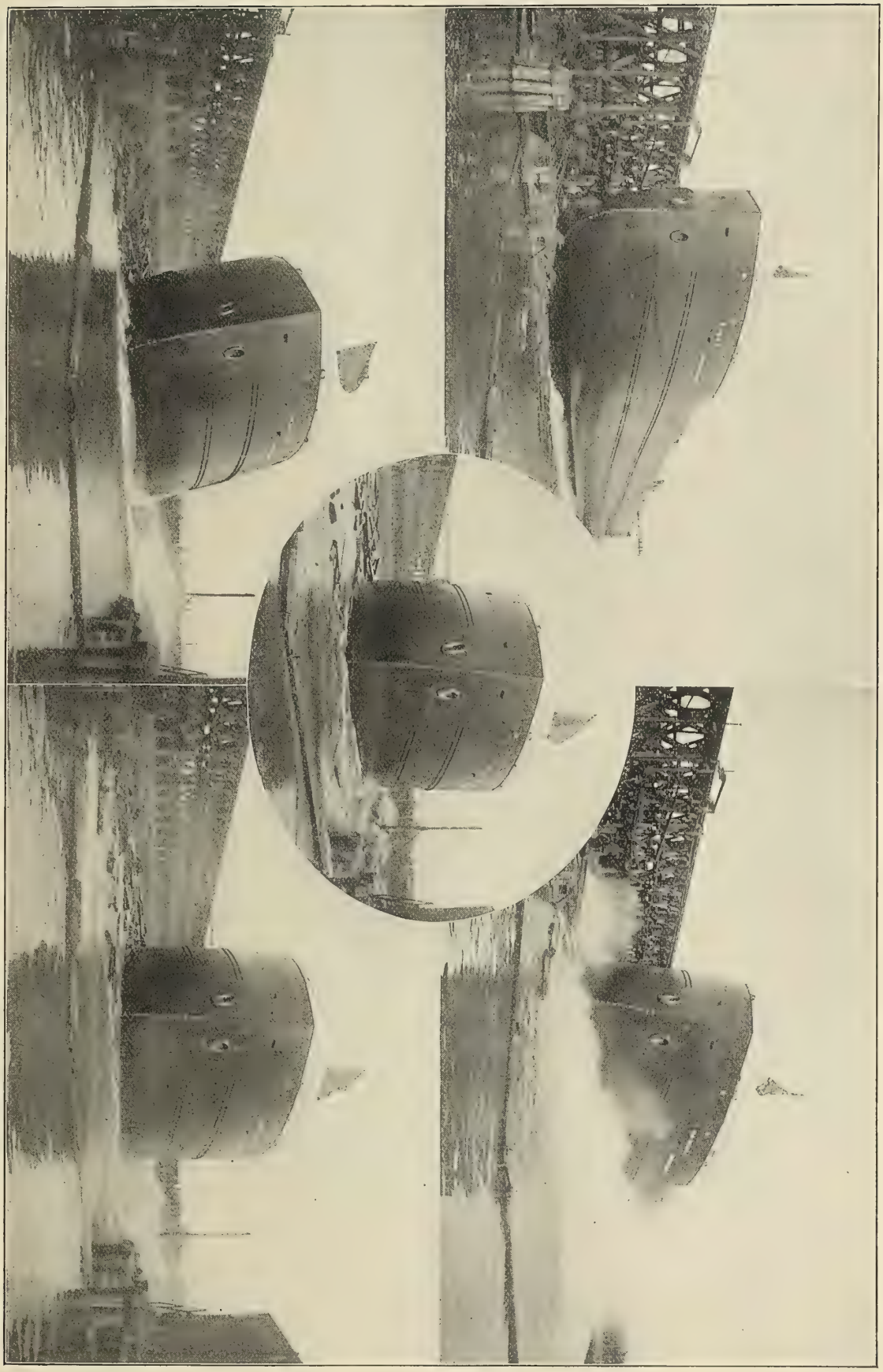
It is computed that on the great ocean highways there are not less than 10,000 large and high-powered steamers constantly employed. This naturally suggests the question, are sailing ships holding their own in the competition for the world's carrying trade? Thirty-five years ago, two-thirds of the world's ocean trade was performed by sailing vessels; to-day, four-fifths is done by steamships. But it must not be supposed that only low-valued cargo is left for the sailers, for this is not the case. They still carry some part of the cotton and wheat, not only because they can carry more cheaply than their competitors, but because they give a somewhat wider choice of market. Cargoes of staple products can always be sold "to arrive" at some given port, and it is quite as cheap—often cheaper—to put them afloat than to warehouse them ashore and wait for a sale.

Broadside Launch of Schooner.

An interesting set of views of the broadside launch of a large steel vessel taken at intervals from the time the vessel commenced to slide off the ways until she was fully waterborne is exhibited on page 47. This vessel is the schooner *Marcella*, for the Minnesota Steamship Co., built by the Chicago Shipbuilding Co. at its South Chicago (Ill.) yard. The vessel is of these dimensions: Length over all 447 ft. 10 in.; length of keel 436 ft.; beam moulded 50 ft.; depth moulded 28 ft. 6 in. In launching, the vessel was carried on 35 ways, which had an inclination of 1 1-2 in. to 1 ft. The bearing surface between the cradle and the ways was so proportioned that the pressure per sq. ft. of surface was about 5 tons. The schooner was designed to meet the requirements of the ore, coal and grain trade of the Great Lakes. We are indebted to E. G. Todt for this excellent set of views.

S.S. Walter Scranton.—The steamer *Walter Scranton* was launched at the Lorain, Ohio, yard of the American Shipbuilding Co. on January 5. The boat was named in honor of the president of the Lackawanna Steel Co., and is of these dimensions: 436 ft. over all; beam, 50 ft., and depth, 28 ft. She will be fitted with triple expansion engines, with cylinders 23 in., 37 1-2 in., and 63 in. dia., with 42 in. stroke. Steam will be supplied by three Scotch boilers 12 1-2 ft. in dia. by 12 ft. long. She will be fitted with Ellis & Eaves draft. The *Walter Scranton* is building for Capt. John Mitchell and others of Cleveland.

S.S. Sithonia.—The large steel screw first class cargo steamer building for the Hamburg-American Line was launched from the yard of the Flensburger Schiffsbau Gesellschaft recently. The vessel, which will be classed to German Lloyd's highest class three deck rule, with accommodations and fittings in accordance with the rules of the Seeberufsgenossenschaft for the prevention of accidents, is of these dimensions: Length, 436 ft.; beam, 56 ft.; and depth moulded, 30 ft. 9 in., having a dead weight capacity of about 9,000 tons. She is to be used for the East Asiatic trade of the company. She was christened by Frau P. Selck.



CONSECUTIVE VIEWS OF THE BROADSIDE LAUNCH OF A LARGE STEEL VESSEL AT THE YARD OF THE CHICAGO SHIPBUILDING CO., SOUTH CHICAGO, ILL.

THE FLOATING DOCK AS AN ADJUNCT TO A WAR NAVY.—II.*

BY LYONEL CLARK, M. I. N. A.

The author ventures to prophesy that in the future, now that all nations both in the New and Old World are recognizing the necessity of colonies, thus extending the area of any future war over the whole globe, the great possibilities of the floating dock in the way of mobility and ready transference from one base to another, will be more fully recognized than they are at present.

A paper like the present, which has developed itself into a comparison between graving and floating docks, would be incomplete without some mention of the comparative costs of the same, their working expenses and cost of up keep.

As regards first cost it is, of course, quite impossible to make any real comparison. The prevalence of the required materials, the ready and abundant supply of cheap labor, largely affects the cost of a graving dock apart from the enormous influence the nature of the soil would have on the design. In a similar way, a rise in the price of ship materials, such as has been seen in the last two years, renders even actual prices of docks useless without copious explanatory notes. It may, however, be generally stated that the floating dock will always come out the cheaper of the two, even when compared with the more or less makeshift type of graving dock as hitherto constructed. Compared with the ideal dock as laid down in these pages, the steel structure will, even where the situation is distinctly favorable to the stone dock, show a very considerable economy. And there is another point in connection with the cost of floating docks of great importance, and that is that they can always be built and completed at their estimated cost. There is no danger to be apprehended from underground springs, no eventualities and unforeseen accidents that so frequently characterize the construction of the ordinary graving dock unless it be of the most expensive character, and built with ample margin of safety.

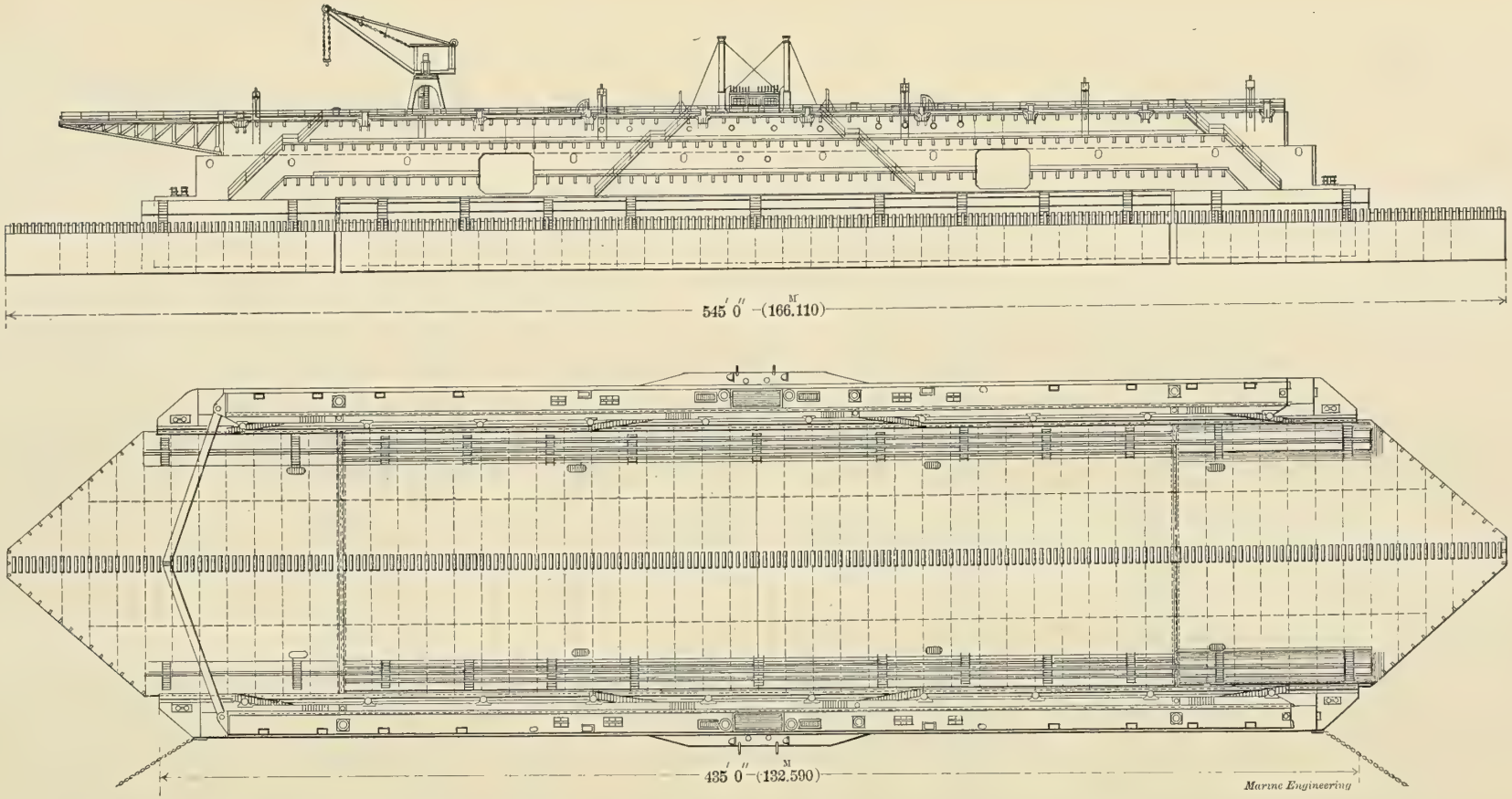
Any shipbuilder can work out a tender for a floating dock as closely as he can for a ship, and make sure of completing it without any more risk in one case than the other. Addressing, therefore, a body of shipbuilders, the author has thought that the best way to give an indication of the cost of these docks is to state the actual weight of material in the hull. With this information an estimate of the actual cost of the hull can at any time be arrived at by any shipbuilder in any country, bearing in mind that the construction of these docks is of the simplest and most straightforward type of tank work. The cost of the machinery and fittings is naturally such a variable quantity, depending so largely on the speed at which the ship is to be lifted that a general statement of

TABLE SHOWING PROPORTION OF STRAIGHT KEEL TO OVER ALL LENGTH FOR VARIOUS SHIPS.

Name of Vessel.	Nationality.	Displacement.		Length.		Length of Straight Keel.		Straight Keel in Terms of Length.	Weight per Ft. Run of Straight Keel.	Weight per Metre Run of Straight Keel.
		English Tons.	Metric Tons.	Ft. Ins.	Metres.	Ft. Ins.	Metres.		English Tons.	Metric Tons.
Kaiser Karl d. VI. .	Austria	6,151	6,250	367 6	112·012	187 6	57·149	0·51	32·81	109·060
*Campania . . .	Great Britain	19,000	19,304	600 0	182·877	527 0	160·626	0·88	36·0	120·240
*Magnificent . . .	„	14,900	15,139	390 0	118·870	343 0	104·544	0·88	43·40	144·956
*Oceanic	„	19,260	19,569	685 0	208·784	559 0	170·380	0·82	34·45	115·063
*Powerful . . .	„	14,200	14,427	500 0	152·397	384 0	117·041	0·768	37·0	123·580
Charlemagne . . .	France	11,097	11,275	385 6	117·498	310 0	94·486	0·80	35·80	119·330
Dupleix	„	7,579	7,700	426 6	129·995	260 0	79·247	0·61	29·15	97·183
Freya	Germany	5,561	5,650	344 5	104·976	187 6	57·149	0·54	29·66	98·594
Kaiser Wilhelm d. Grosse	„	10,827	11,000	377 4	115·009	193 9	59·054	0·52	55·81	186·032
A.B. (new vessel) . .	Italy	7,874	8,000	400 0	121·918	164 0	49·986	0·41	48·01	157·469
Idzumo	Japan	9,750	9,888	400 0	121·918	231 3	70·407	0·58	42·20	140·948
*Shikishima .	„	14,850	15,088	400 0	121·918	310 0	94·486	0·77	47·90	159·986

Dimensions of vessels marked thus * have been obtained from the owners or builders direct. The lengths of straight keel for other vessels have been computed from diagrams in Brassey's 1900 Annual.

*A paper read before the International Congress of Naval Architecture, Paris, 1900.



PLAN AND SECTIONAL ELEVATION OF THE BRITISH FLOATING DOCK FOR BERMUDA, BUILDING BY C. S. SWAN & HUNTER, WALLSEND-ON-TYNE, ENGLAND.—FIG. 1.

their cost is no more possible than would be one of a ship where no speed or engine power was specified.

In cost of working, the graving dock will have a slight advantage in the number of men required, by at most one or two hands, but this is more than compensated for by the great saving in coal, etc., in the floating dock already alluded to, and the ultimate difference between the two would be quite negligible.

In cost of upkeep, the graving dock should theoretically show a great advantage over the steel structure, if it is thoroughly well constructed in the first place. In practice, however, there are always a number of small repairs, and there is the constant running of the drainage pumps to be put against this advantage.

In a floating dock the cost of upkeep can in practice be kept very low, if small repairs and general touching up are done by the crew of the dock, and indeed it resolves itself then into merely the cost of paint and material.

The amount of overhaul required will again depend very largely on the nature of the water in which the dock is moored, and it may require complete repainting every year or so, or it may go, as is the case with one dock designed by the author's firm, some twelve years without wanting its underwater portion in any way touched.

From actual figures relating to the cost of repairs to a floating dock under average conditions of site, which was allowed to go nine years without any attention, it was found that the cost of a complete overhaul of both hull and machinery amounted to about 7 per cent. of the first cost of the dock alone. Assuming, therefore, that such overhauls were again required at equal periods, it follows that the setting apart of a sum, not so much as one per cent. per annum of the first cost of the dock, would suffice to keep it in proper and permanent repair.

It is not proposed to enter into any description of the particular form of floating dock that the author's firm has introduced more especially for use in a modern war navy, as the same has been fully described in the Proceedings of the Institution of Naval Architects, vol. xxxviii, but some illustrations are appended which show the general form and give main dimensions.

The first of these illustrates the floating dock that the author's firm is at present designing for the British Government, and which is to be placed at Bermuda, and the contract for the building of which has been placed in the hands of C. S. Swan & Hunter, of Wallsend-on-Tyne. (Fig. 1.)

The length of this dock is 545 ft. 0 in. over the keel blocks, its width of entrance 100 ft. 0 in., and it is capable of normally taking vessels drawing 33 ft. 0 in. of water over keel-blocks 4 ft. 0 in high. At the immersion the walls have a freeboard of 3 ft. 6 in., which in urgent cases might be safely reduced by a foot or more in order to increase the depth of water over the blocks. Its lifting power up to pontoon deck level is 15,500 tons, but by utilizing the pound formed by the bulwark surrounding the pontoon decks, additional lifting power up to 17,500 tons can be gained.

The dock is most complete in every respect, being furnished with electric lighting installation, electric cranes of five ton power running along on top of each wall, and powerful steam vertical capstans that can deal with the largest ironclads. The top decks are covered with teak, with arrangements for catching and storing all rain water, and the bottom is protected by greenheart keelsons to prevent damage to the skin should the dock, in cases of extreme low tide, have to sit on the coral that forms the bottom of its permanent site. The engine power of this dock is sufficient to lift an ironclad displacing 15,000 tons in three and a half hours. It will be built on the Tyne, completed and tested there, and towed to its destination as a complete structure.

The hull weight of this dock, by which is meant the quantity of steel plates, bars and shapes, rivets, bolts, etc., and all other material essentially necessary to the dock, but not including machinery, timber, or any other fittings which may be varied to suit the desires of the owner, amounts to 6,500 tons.

The second dock, of which a plan is shown in Fig. 2, is one that the author's firm has designed for the Navy Department of the United States, and which is now fast approaching completion in the Sparrow's Point Shipyard, Maryland. Its length is 525 ft. 0 in. over blocks, and entrance 100 ft. 0 in broad, and it has a lifting power up to pontoon deck level of 18,000 tons. In this case no provision has been made for utilizing the pound of the dock, but the same could be added, at an extremely small cost, at any future time should it be required to increase the lifting power to not above 20,000 tons. In general shape this dock closely resembles the one for the British Government, but the plan is given in order to show how the dock, which is to be placed at Algiers,* a suburb of New Orleans, La., is moored in the current of the Mississippi. The dock itself is attached to strong steel columns, sunk in the foreshore, by means of steel lattice booms articulated in all directions. The dock is, therefore, free to rise and fall with the river which is subject to very severe freshets, frequently rising

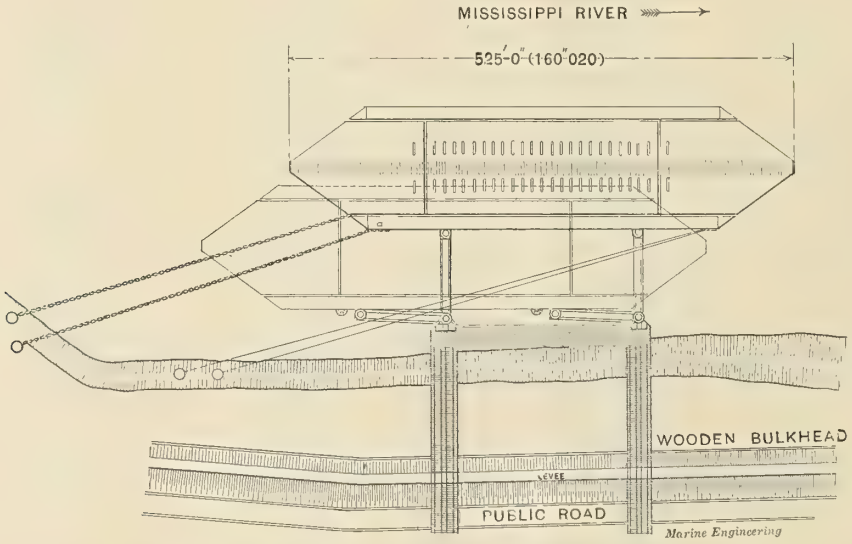
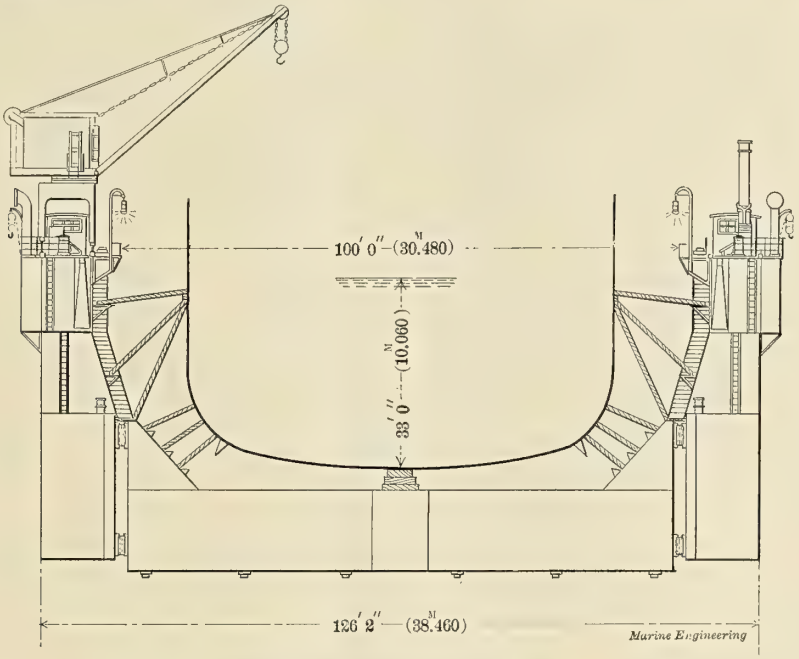


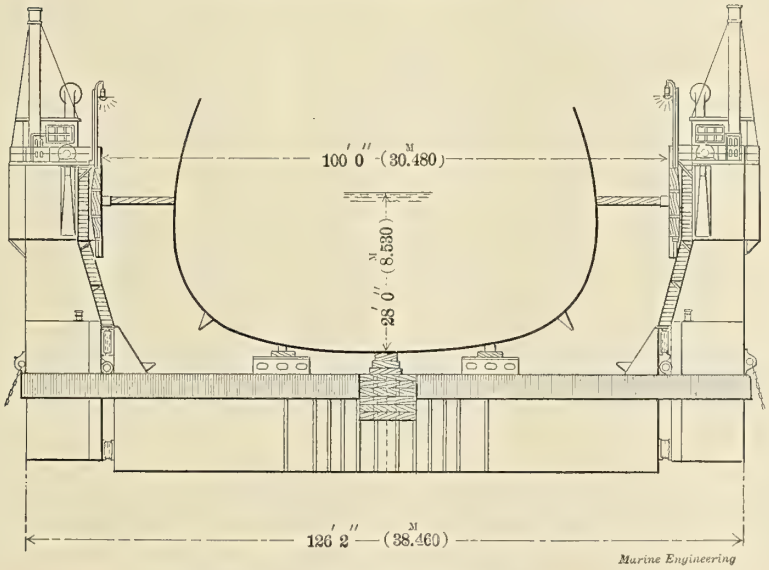
FIG. 2.—PLAN OF FLOATING DOCK AND LOCATION AT ALGIERS, LA.

*For more extensive descriptions of the Algiers dock see Marine Engineering, Vol. V, p. 49, and this vol. p. 20.—Editor M. E.

some 20 ft. 0 in. above gulf level, and at the same time can be swung in-shore out of the worst of the current, which here occasionally attains a speed as high as four miles an hour. The booms at the same time form gangways, by which approach may be had to the dock and material conveyed thereon. It may also be noted that this form of attachment to the shore allows all the moorings to be made fast to dolphins together because they show so well the different methods adopted by the Governments of the two countries for the shoring or berthing of the ships on the dock. The English custom and also that of Italy and Japan is to support the armor belt on more or less vertical shores inserted under an angle iron firmly attached to the same. These shores are put in position as the ship is rising, and, as the water recedes, more



CROSS SECTION BERMUDA DOCK —FIG. 3.



CROSS SECTION ALGIERS DOCK.—FIG. 4.

driven into the river bank, and leaves the sea side of the dock quite open for maneuvering or anchoring other vessels that may be at the station.

This dock will also be completed at the builders' yard and towed to its destination. Its hull weight is 5,850 tons.

The end elevations of these two docks are placed and more shores are inserted. It will be noticed that the Bermuda dock has large and powerful altars constructed for this purpose. (Fig. 3.)

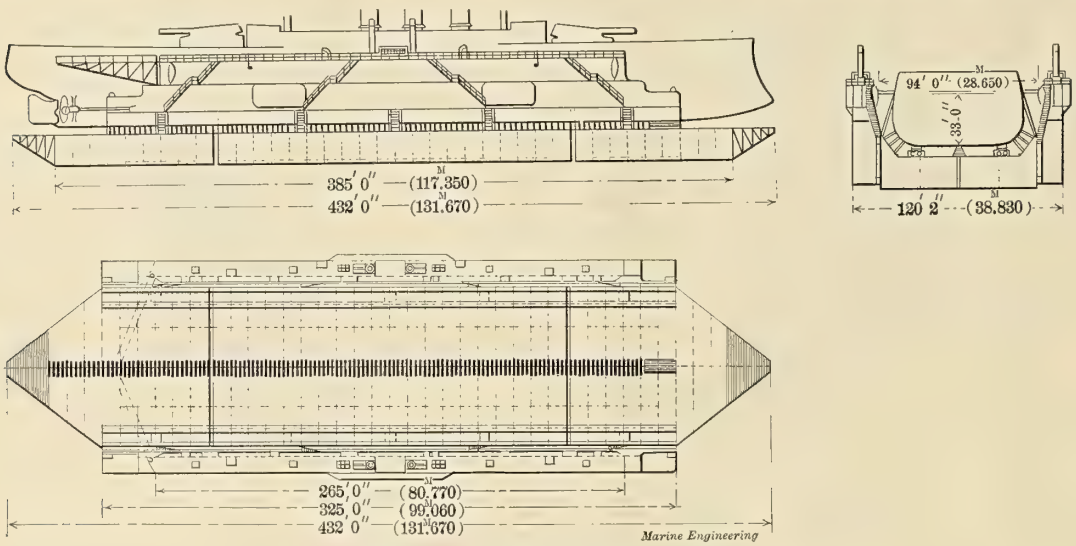
The American custom, on the contrary, is to strengthen the bilges of their ironclads with strong bilge or docking keels, forming, with the keel proper, a level bottom. No shores are required beyond those

necessary to roughly center the vessel, and no great care is required in adjusting the berth, and one set of bilge blocks does for all sizes of vessels. (Fig. 4.)

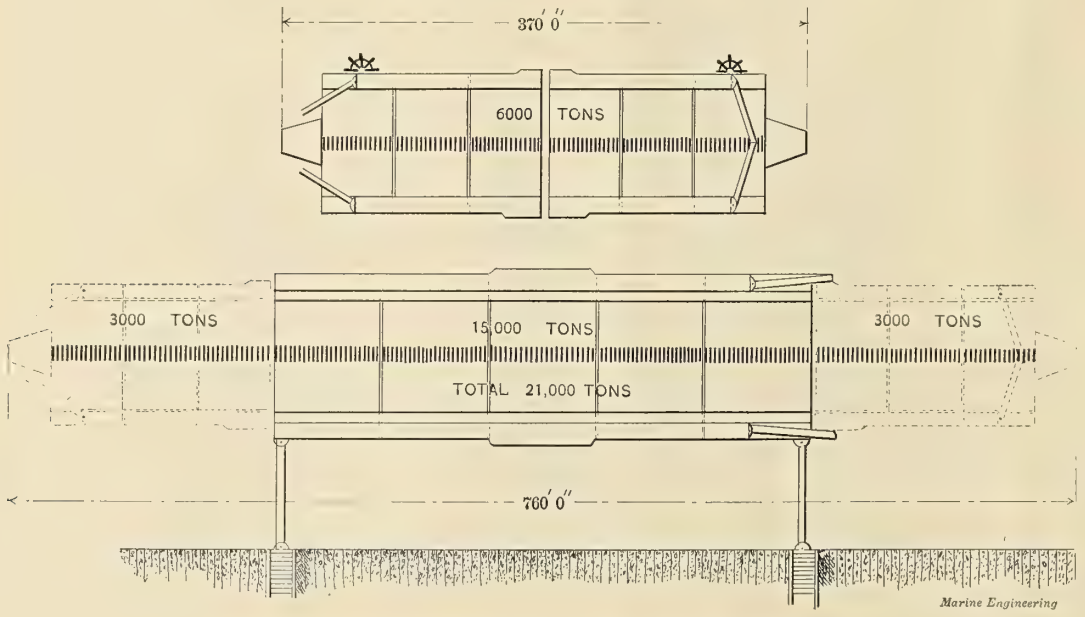
If the author's long experience in the study of docking vessels will warrant him giving an opinion on the two methods, he would like most strongly to express his very great preference for the American plan. It affords a great saving in weight and quantity of shores, a complete set of which has practically

center and adjust her with shores disposed according to English practice.

The two docks above mentioned are actually being built, but a further illustration is shown (Fig. 5) of a similar form of dock, designed, however, solely for the use of ironclads or short cruisers, that is, for a navy that does not include ocean liners amongst its units—as a matter of fact, the Japanese Navy was the one in view. Its lifting power is 15,000 tons to



DOCK DESIGNED EXCLUSIVELY FOR NAVAL VESSELS.—FIG. 5.



COMBINATION DOCK DESIGNED FOR GENERAL SHIPYARD USE.—FIG. 6.

either to be kept in store to suit each type of ironclad or specially cut for such vessels, and, what is more important, it effects great saving in time, not only in the preparation of the berth and centering of the ship, but also in the actual lifting of the same. With the American plan it would be perfectly feasible to dock a vessel completely in the time required to

pontoon deck, it has been given a slightly narrower entrance, and generally has been kept as light as is compatible with strength. The hull weight of this dock is only 5,050 tons or 33.3 tons of steel for every 100 tons of ship lifted.

One other form of dock is shown in Fig. 6, which may be called a combination dock, and its use would

be peculiarly suitable to a large shipbuilding yard undertaking the construction of vessels of all types. This dock consists of three parts, a central one of a length of 386 ft. 0 in (118 meters) and a lifting power of 15,000 tons, especially strengthened for the shoring up of ironclads, and two smaller docks each of 3,000 tons, which can either be attached one at each end of the central portion, thus bringing its length up to 700 ft. 0 in (215 meters) over blocks, or 760 ft. 0 in. (232 meters) over all, and lifting power to 21,000 tons; or which are capable of acting either separately or together, in the latter case forming a dock of a length of 370 ft. 0 in. (113 meters) and a lifting power of 6,000 tons suitable for dealing with ordinary merchant vessels. The total hull weights of these docks amounts to 8,550 tons, which represents about 36.5 tons of steel for each 100 tons of vessel lifted. It may be remarked that this form really gives a double dock, each half of which can be worked quite independently, being, therefore, much superior to the graving dock divided in its center with an additional gate, where the innermost vessel may be blocked indefinitely by any accident to the outermost one. It is also worthy of note for future requirements, that the dock would provide sufficient bearing surface for a vessel 900 ft. 0 in. (275 meters) over all, if built on the same lines as the *Oceanic*.

Many other examples of docks might be shown suitable for certain cases. The steel dock is essentially elastic and easily adapts itself to the peculiarities of the work it has to do. It is not, however, the wish of the author that the present memoir should develop into a catalogue of docks, but rather to call attention to the great facilities afforded by the floating dock and more especially those which render it so suitable to the uses of a modern navy.

That the author should have faith in the future of the floating dock is only what is to be expected, but he may perhaps put forward, as independent justification of his belief, the fact that, although the present type of dock was only introduced in 1896, his firm have already been commissioned to design five of these structures of an aggregate lifting power of 61,000 tons, two of which are among the largest docks extant, and three of which are for the requirements of various governments.

Indeed, the ordinary law of evolution should tend to show that the floating dock is to be the engine of the future. We are now in the full flood of the constructive age of steel. This metal has already replaced the timber of our roofs and the masonry of our bridges, and in the United States it now forms the strength portion of all large modern buildings. There should surely be no great venture in prophesying that in the near future the same material must replace the more unwieldy and cumbersome masses of masonry that represent at present the ordinary form of naval graving docks.

U. S. S. Talbot.—The oil fuel experiments which had been carried out by the Bureau of Steam Engineering of the U. S. Navy on board the torpedo boat *Talbot* are to be discontinued. The furnaces and the boilers will be altered for coal fuel and the boat will probably be put into regular service again.

MACHINERY FOR THE NEW U. S. BATTLESHIPS AND ARMORED CRUISERS.

Designs for the engines of the new battleships of the *Georgia* class, and of the armored cruisers of the *California* class, have been prepared in the Bureau of Steam Engineering of the Navy under the supervision of Engineer-in-Chief George W. Melville. These designs are of special interest, as they represent very large units and embody all those features which experience in both war and peace times has suggested. In general design the engines are of the Navy type, having forged steel framing and crank shafts of the pattern adopted in our naval service. In each case the engines are of the inverted, direct acting, triple expansion, four cylinder, four crank type. They will be installed in water tight compartments separated by a middle line bulkhead. Each vessel will have two complete sets of engines driving twin screws.

The engines for the battleships will each have a high pressure cylinder 35 in. dia., and intermediate pressure cylinder 57 in. dia. and two low pressure cylinders 66 in. dia., the stroke of all pistons being 48 in.

The engines for the armored cruisers will each have a high pressure cylinder 38 1-2 in. dia., an intermediate pressure cylinder 63 1-2 in. dia., and two low pressure cylinders 74 in. dia., the stroke of all pistons being 48 in.

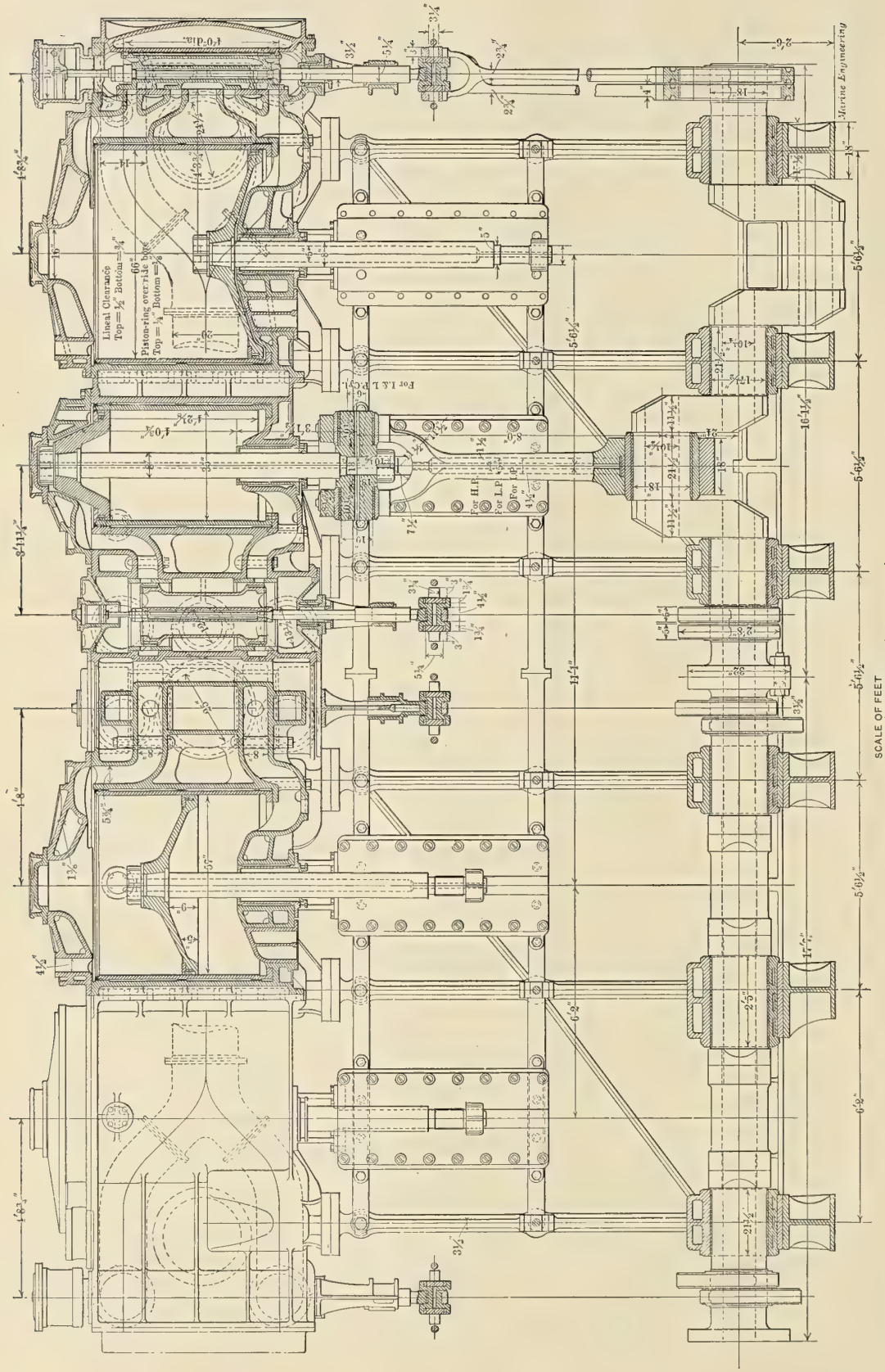
The indicated horse power of the propelling engines with 250 lb. of steam at the engines, and when making 120 revolutions, will be 19,000 for the battleships and 23,000 for the cruisers. These powers are calculated to drive the vessels at 19 and 22 knots respectively.

The order of the cylinders, beginning forward, is: Forward low pressure, high pressure, intermediate pressure, and after low pressure. The forward low pressure and high pressure cranks are opposite, also the intermediate and after low pressure cranks, the second pair being at 90 deg. to the first. The sequence of cranks is thus: High pressure, intermediate pressure, forward low pressure, and after low pressure.

All the cylinders will have working linings of hard cast iron, the spaces around being used as steam jackets. All cylinders of the cruisers and the intermediate and low pressure cylinders of the battleships have steam jackets at both ends.

The main valves are all worked by Stephenson double bar links, and the valve gear for all four cylinders of each set is made interchangeable so far as practicable.

There is one single ported piston valve for each high pressure cylinder, and two for each intermediate pressure cylinder. These valves are of cast iron, made hollow to allow the passage of steam between the ends of the valve. Packing rings are of hard cast iron held in place by followers, the rings being bolted together to allow of contraction, but not of expansion. For each low pressure cylinder there is a double ported balanced slide valve. All valves are fitted with balance pistons, working in cylinders on top of the valve chests. The high pressure valve takes steam at center and exhausts at the ends. The intermediate pressure valve takes steam at ends and exhausts at the center,



SECTIONAL ELEVATION OF FOUR CYLINDER, FOUR CRANK, TRIPLE EXPANSION TWIN SCREW ENGINES FOR U. S. BATTLESHIPS 13 TO 17=19,000 COLLECTIVE I. H. P.

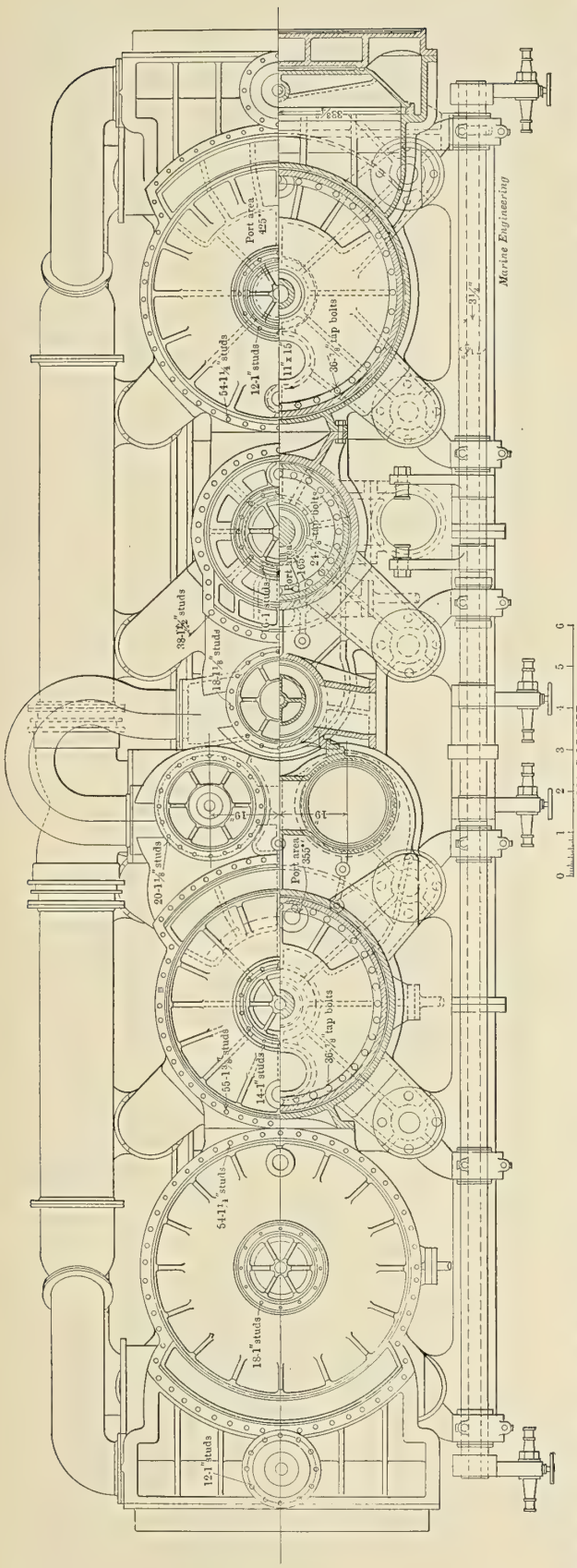
the exhaust being taken from one cylinder to the next through copper receiver pipes.

The framing of the engines consists of forged steel columns trussed by forged steel stays. All main shafting is hollow forged nickel steel, having a tensile test of at least 80,000 lb. per sq. in., an elastic limit of not less than 50,000 lb. and an elongation in 2 in. of not less than 25 per cent.

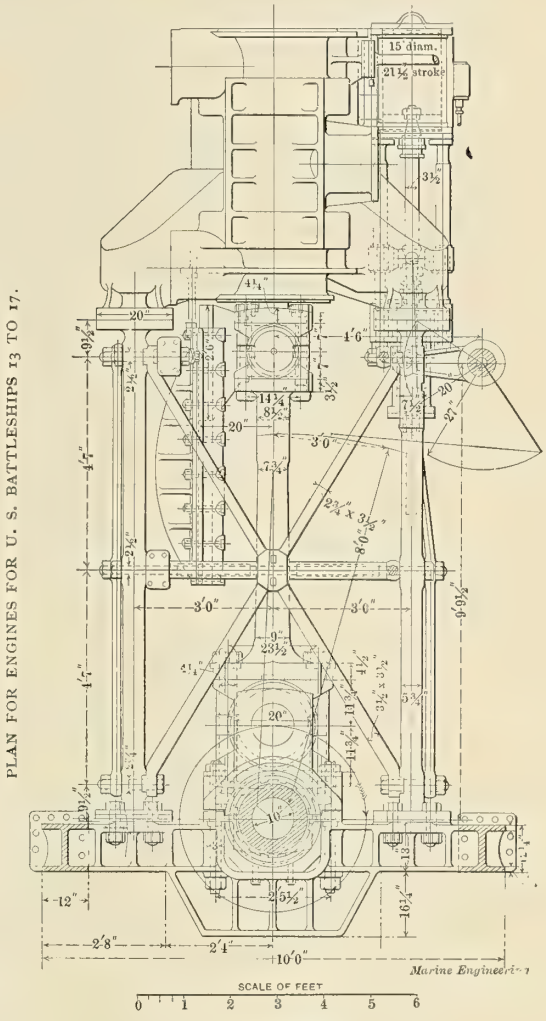
All connecting and piston rods are of hollow forged nickel steel, oil tempered and annealed, having a tensile strength of not less than 95,000 lb., elastic limit not less than 65,000 lb., and elongation in 2 in. of 21 per cent.

The condensers will be cylindrical, the shells being made of steel boiler plate and the ends of composition. The material, spacing and packing of the tubes will conform to the usual naval requirements.

The propellers will be of manganese bronze, the blades being cast separate from the hubs and bolted on. The starboard propeller will be left hand and the port right hand, which will make the top blades turn inboard when going ahead; this is done in order to allow the

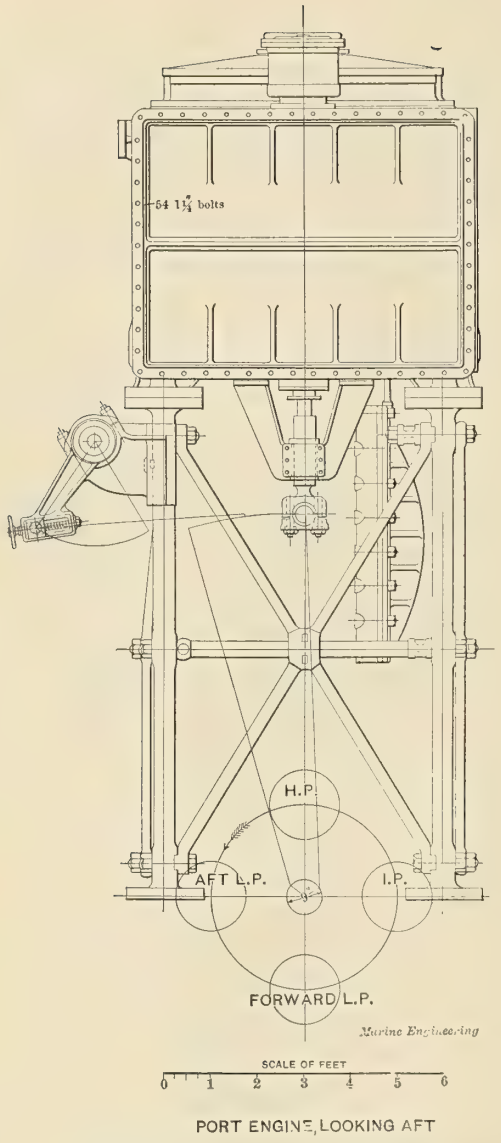


PLAN FOR ENGINES FOR U. S. BATTLESHIPS 13 TO 17.



H. P. CYLINDER
PORT ENGINE LOOKING FORWARD

END ELEVATION—BATTLESHIP ENGINES.



PORT ENGINE, LOOKING AFT

CRANK AND VALVE GEAR CENTERS—BATTLESHIP ENGINES.

slides to be bolted on the rear columns of the engines and have everything clear on the working platform side. There will be a bilge pump worked by each main engine.

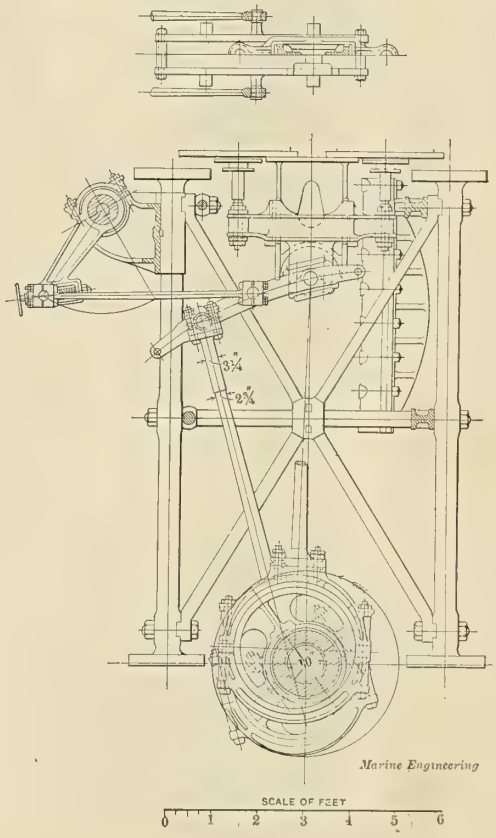
All other auxiliary machinery will be independent of the main engine. The main air pumps will be double vertical and single acting; the main circulating pumps will be centrifugal; main feed pumps will be of the vertical compound double acting plunger type. Arrangements will be made for turning the exhaust from the auxiliary machinery into either main condenser, into either auxiliary condenser, into either low pressure receiver, into either feed water heater, or into the atmosphere at will.

There will be four evaporators, having a combined capacity sufficient to make 1 gal. of water in twenty-four hours for each indicated horse power of the main engines, and having a square foot of heating surface for each 20 gal. of daily output. There will be three distillers having a combined capacity of 10,000 gal. of potable water in twenty-four hours, each distiller having at least 66 sq. ft. of tube cooling surface.

The boilers are to be of the water tube type, the choice of type being left to the contractors, with certain limitations. All parts of the boilers subject to pressure must be of wrought steel. There will be no screw joints in contact with the fire. Generating tubes must be straight and not less than 2 in. dia. Steam drums must be of sufficient diameter to admit a man. Grates must not be over 6 ft. 10 in. deep. Tubes must be of the following thickness: 2 in. tubes, No. 8 B. W. G. 3 and 4 in. tubes, No. 6 B. W. G.

The battleships are each to have twenty-four boilers placed in six water tight compartments, the total grate surface to be not less than 1,280 sq. ft., and the total heating surface not less than 55,000 sq. ft. The armored cruisers are to have thirty boilers placed in eight water tight compartments, the two forward compartments containing three boilers each and the other six compartments four each. These vessels are to have not less than 1,590 sq. ft. of grate surface and 68,000 sq. ft. of heating surface. The battleships will have three and the armored cruisers four smoke pipes extending about 90 ft. above the grates.

The forced draft system will consist of blowers discharging into closed ash pits and there will be two blowers in each boiler compartment. The working pressure will be 265 lb. per sq. in. at the boilers and 250 lb. at the engines. The steaming capacity of the boilers must be such that all steam machinery on board



PORT ENGINE, LOOKING AFT.

DETAILS OF VALVE GEAR—BATTLESHIP ENGINES.

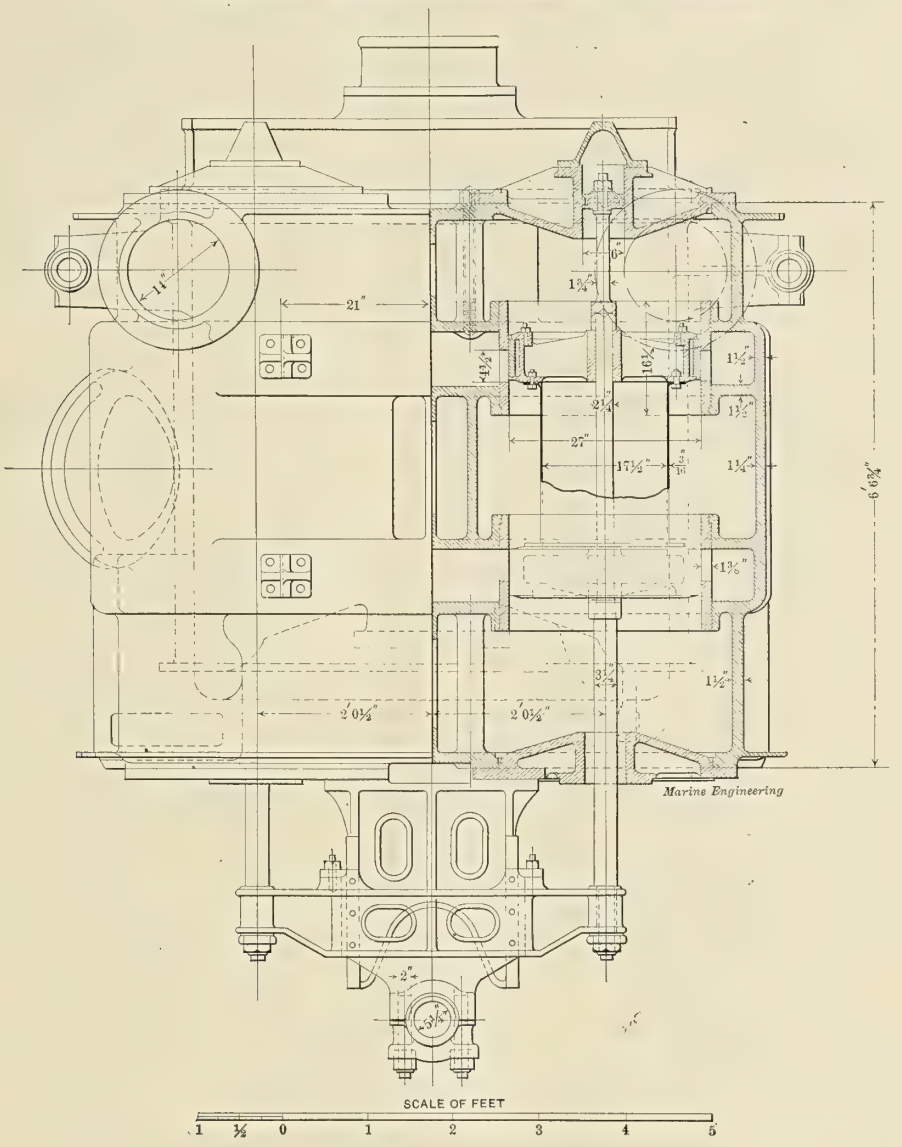
can be run at full power with an average air pressure in the ash pits of not more than 1 in. of water.

All steam pipes above 2 in. dia. will be of seamless drawn steel with flanges of the same metal either welded to the pipe or beaded over to fit a recess flush with the face of the flange. All pipes will be so fitted as to put them under stress when cold by allowing for every 10 ft. of length when bolting up a clearance between flanges of 3-16 in. for steam pipes and 3-32 in. for exhaust and feed pipes.

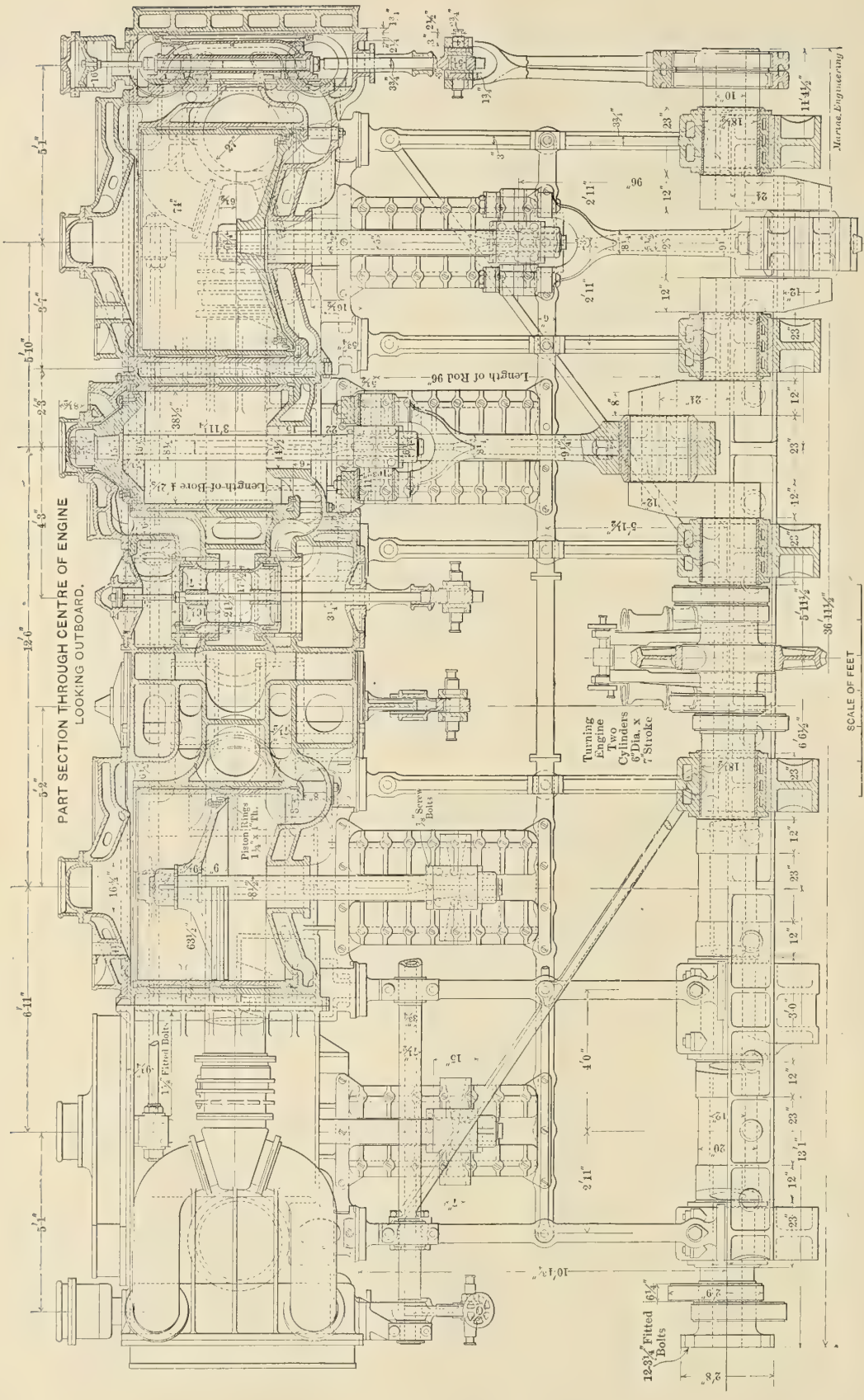
The electric plants for three of the battleships (those having superimposed turrets at the ends and two waist turrets) will consist of eight units, for the other two battleships ten units, and for the armored cruisers seven units, each unit to consist of an engine and dynamo mounted on a combination bedplate. Two units of the battleships will have a rated output of 1,250 amperes at 80 volts and the remaining units will have a rated output of 625 amperes at 80 volts. Three units of the armored cruisers will have a rated output of 1,250 amperes at 80 volts and the other four units 625 amperes at 80 volts. There will be an auxiliary condenser in the dynamo room with its own air and circulating pump, thereby making this plant entirely independent of all others.

These vessels will each be furnished with a general workshop, with proper line and counter shafting run by an electric motor. Each workshop will contain the following power tools: One screw cutting back geared gap lathe, to swing 30 in. over the bed and to take 10 ft. between centers; one 14 in. screw cutting back geared lathe, to take 4 ft. between centers; one column shaping machine 15 in. stroke and 26 in. traverse; one double geared drilling machine, to drill up to 1 1-2 in., 18 in. from edge of work; one universal milling machine; one combined hand punch and shears with

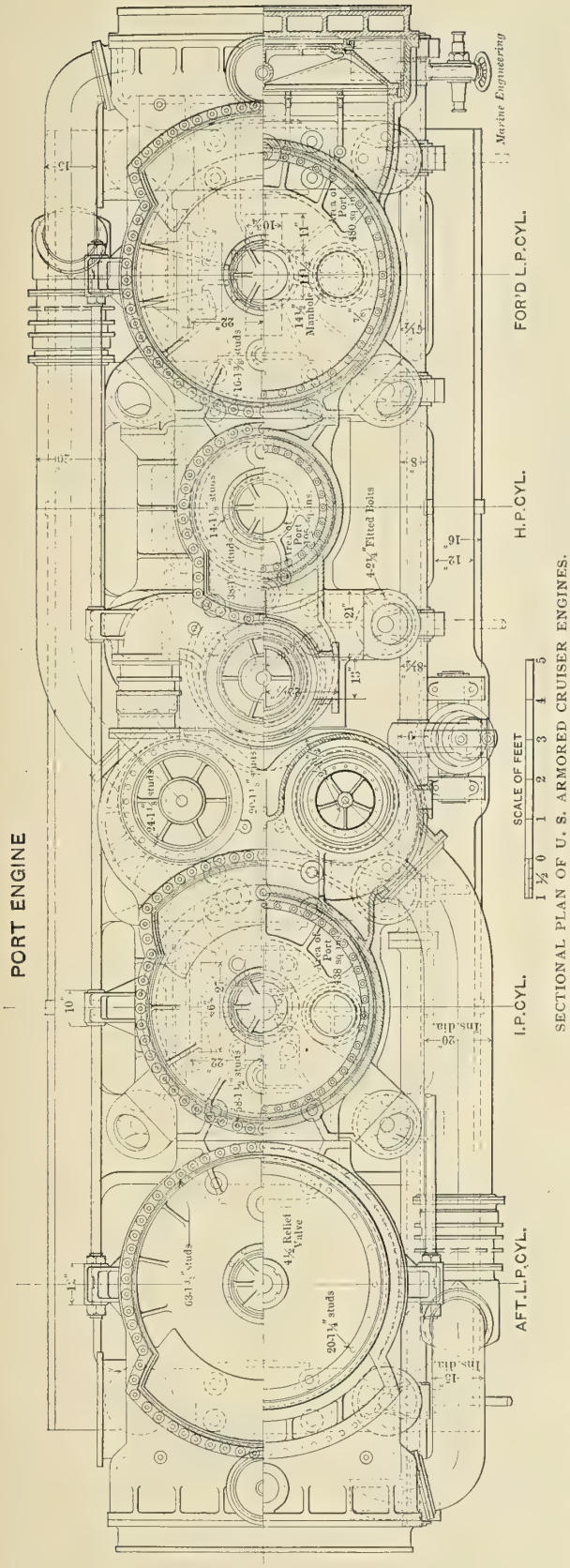
I. P. CYLINDER AND PART SECTION THROUGH I. P. CYL. VALVE CHEST.



DETAILS OF VALVE CHEST DOUBLE PISTON VALVES AND YOKE FOR U. S. CRUISER ENGINES.


PART SECTION THROUGH CENTRE OF ENGINE
LOOKING OUTBOARD.
Length of Rod 96"
Length of Bore 4 2½"
Turning Engine Two Cylinders 6" Dia. x 7" Stroke
Piston Rings 1½" Th
1" Screw Bolts
1⅛ Fitted Bolts
12 3¼" Fitted Bolts
SCALE OF FEET
0 1 2 3 4 5 6
Marine Engineering

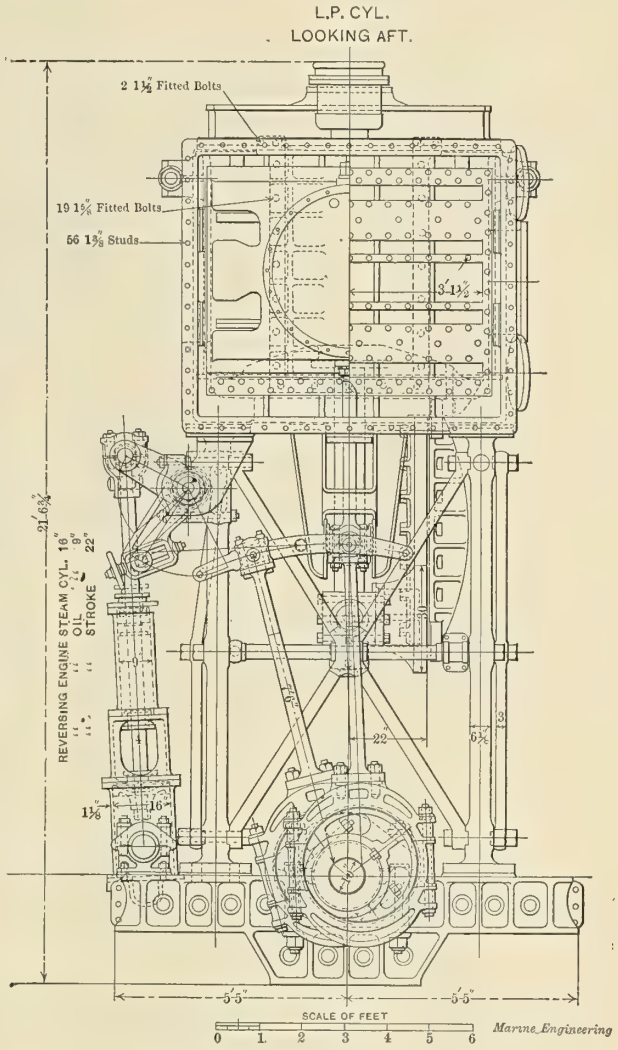
SECTIONAL ELEVATION OF FOUR CYLINDER FOUR CRANK, TRIPLE EXPANSION TWIN SCREW ENGINES FOR U. S. ARMORED CRUISERS NOS. 4 TO 9—23,000 I. H. P. COLLECTIVE.



6 in. shear blades, to cut 3-4 in. round iron and 3-8 in. plate, and to punch 3-8 in. holes in 3-8 in. plates; one emery grinder, with two 12 in. by 2 in. wheels; one 30 in. grindstone. There will also be six bench vises and all necessary and usual spare parts and tools.

The weight of all machinery, including water in condensers, piping, etc., is limited to 1,730 tons for the battleships and 2,060 tons for the cruisers.

Names for the battleships are as follows: *Georgia, New Jersey, Pennsylvania, Rhode Island* and *Virginia.*



END ELEVATION U. S. ARMORED CRUISER ENGINES.

The armored cruisers will be called *California, Colorado, Maryland, Nebraska, South Dakota* and *West Virgina* respectively.

Details of the contracts under which these vessels are to be constructed were published in our January issue.

John Lambert, ex-president of the American Steel & Wire Co., is credited with the statement that, with John W. Gates and other associates, he will establish an extensive shipyard on the Atlantic coast in the event of the passage of the Ship Subsidy bill by Congress.

SUBMARINE BOATS — FROM THE EARLIEST RECORDS DOWN TO THE PRESENT.*—V.

BY CARL BUSLEY.

CHAPTER XX.

Lake's Argonaut, 1899.—In 1897 an American, Simon Lake, in Baltimore, undertook the construction of a boat which he called the *Argonaut*, and which was intended to assist in divers' work on sunken vessels. At the beginning of the Spanish-American war Mr. Lake wanted to attract the attention of the U. S. Navy to his boat, as he thought that it could be used in warfare. He accordingly made lengthy trial trips under water, and it is reported that these gave very encouraging results. The principal dimensions of this boat are: Length, 36 ft.; beam, 8 ft. 10 in., and displacement, when completely submerged, 57 tons. A 30 H. P. naphtha motor drives the propeller when the boat sails on the surface, and also drives two wheels when it is intended to ride on the bottom. In order to bring his invention into greater prominence, Lake built a second and larger *Argonaut* in 1899, shown in Fig. 49. This one is 65 1-2 ft. long, 9 ft. 10 in. beam, and displaces 100 tons when completely submerged. The compressed air for the crew is carried in two tanks of Mannesman tubing at a pressure of 3,000 lb. and which are located forward under the deck. The new *Argonaut* is fitted with two naphtha motors with a total of 60 H. P., which drive the propeller when sailing on the surface of the water, and the two forward wheels when on the bottom. A wheel attached to the rudder steers the boat under the latter condition. A 4 H. P. auxiliary engine drives the dynamo for the forward searchlight and the incandescent lights for interior lighting. It also drives the air compresser for compressing the air in the divers' lock, located behind the forward searchlight. A diver can leave the vessel from this compartment by means of the water-tight door in the floor. This compartment is also connected with the other compartment by means of an air lock. In the rear of the air lock is the crews' quarters, then the pumping space and the engine room. When it is required to go below the surface, the heavy anchors forward and aft are lowered and the double bottom is filled with water till the boat has very little buoyancy. Then the anchor cables are drawn in, and this pulls the boat down to the bottom. The part of the keel shown in section in Fig. 49 is a safety weight, and can be detached in case of danger in order to bring the boat quickly to the surface. The *Argonaut* is supposed to have attained a speed of 8 knots on the surface, and on the bottom a speed of 6 knots, even on quicksand. The tank aft is supposed to hold sufficient fuel to give her a radius of action of 1,500 miles. Even if this were the case, although it does not appear plausible, the whole construction of the *Argonaut* and method of handling would not adapt itself for an attack on an enemy's

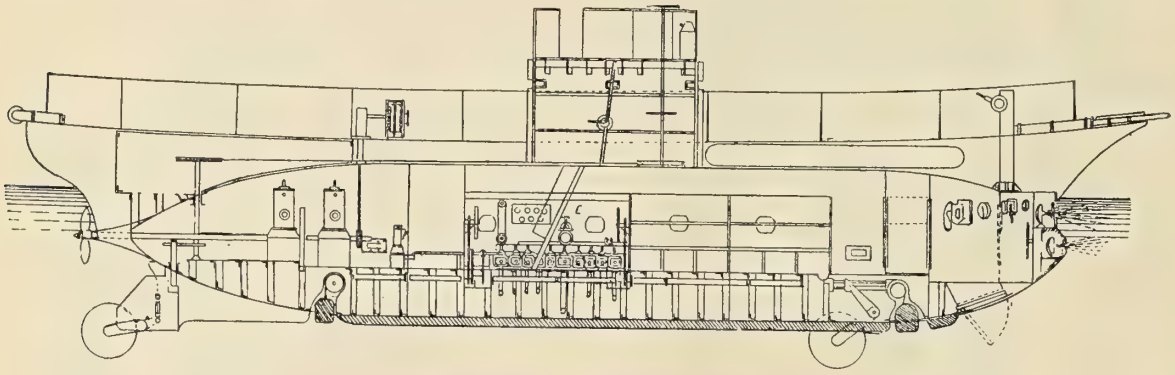
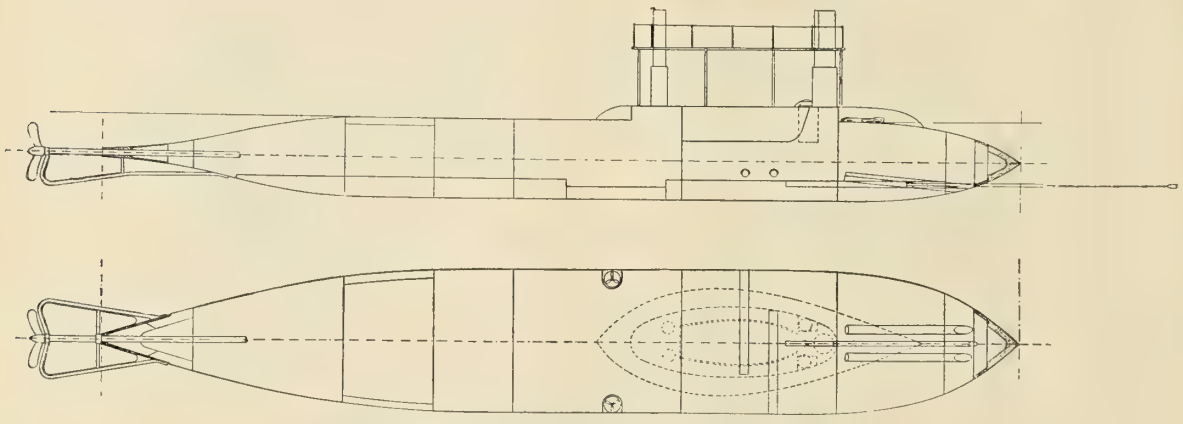


FIG. 49—LAKE'S ARGONAUT, 1899.



FIGS. 50 AND 51.—HOVGAARD'S BOAT, 1887. SEE PAGE 61.

*Translated from the Proceedings of the German Society of Naval Architects and Marine Engineers, Berlin, Germany.

ships nearly as well as a type of partially submerged boat described at a later point.

CHAPTER XXI.

Summary of the Submarine Type of Boat.—Submarine boats in general are cigar shaped, as this is without doubt the most favorable for propulsion beneath the surface. The large conning towers of the earlier type have gradually diminished in size in order to decrease the resistance to propulsion. Omitting the patterns of Vogel and Drzwiecki, the hull dimensions have been gradually increasing up to the present time, at which the figure for displacement is 450 tons. All the large boats have been driven by steam power with the exception of the *Plongeur*, where compresed air was used. Steam was generated in a boiler when both above and below the surface, as in the Vogel pattern, or generated in a boiler when above the surface and drawn from a storage tank of superheated water when below the surface. Only the very recent boats were equipped entirely with motors and storage batteries, and the use of the latter has no doubt diminished both their speed and radius of action in comparison with the older types. It can be safely said that the speed of submarine boats below the surface does not exceed 5 knots, and on the surface 8 knots, and that these figures apply to the older as well as the modern boats. In the largest boats the poor fore and aft stability has been a marked feature, and the attempts to correct this are very evident from the varieties of horizontal rudder and vertical propeller equipments. Another marked improvement was made when the diving or sinking to certain depths was not attempted by merely taking in water ballast, but by altering the displacement at the same time. In spite of all the improvements, however, the dangers of submarine navigation have not been diminished; even if there have been fewer accidents in latter years, it can be attributed entirely to greater timidity and lack of confidence on the part of the crews.

Section 3—Partially Submerged Boats.

CHAPTER XXII.

Hovgaard's Boat, 1887.—In 1887 a Danish naval officer, Hovgaard, published the plans of a partially submerged boat of about the same length as the *Plongeur*, but with a considerably larger displacement. His boat was to have the following dimensions: Length, 150 ft.; beam, 22 ft.; depth, 14 ft. (Figs. 50 and 51). The displacement was to be 740 tons, of which 100 tons was intended for the engine plant, 40 tons for coal, and 60 tons for a motor with its storage batteries. When sailing on the surface the boat was to be propelled by means of a compound engine of 1,400 I. H. P., and attain a speed of 15 knots. Two locomotive boilers with telescopic funnels were to supply the steam. In the partially submerged condition Hovgaard expected to make seven knots by driving with the 120 H. P. motor and its storage batteries, which latter had a capacity for six hours, so that the boat would be able to sail a distance of 42 miles under the above named condition. When developing the maximum power sailing on the surface the coal capacity was supposed to be sufficient to last 18 to 19 hours, in which the boat would cover 250 miles, and when sailing at reduced speed of 10 knots about 900 miles. The boat was to be built of steel, and the stem and stern frame of cast steel. It was divided into ten compartments by means of nine water tight bulkheads, and to have a midship section, as shown in Fig. 52. The double bottom was intended to hold 60 tons of water ballast, when floating on her normal water line, and to bring the top of the boat level with the water surface 20 tons more were to be added to this. The boat was fitted with a small navigator's bridge, which projected about 13 ft. above the water when floating at her normal draft. This bridge, with the two funnels, was to be lowered when she assumed her deep draft, and was to be stowed around a lifeboat which she carried. This life boat was to be placed in a depression in the

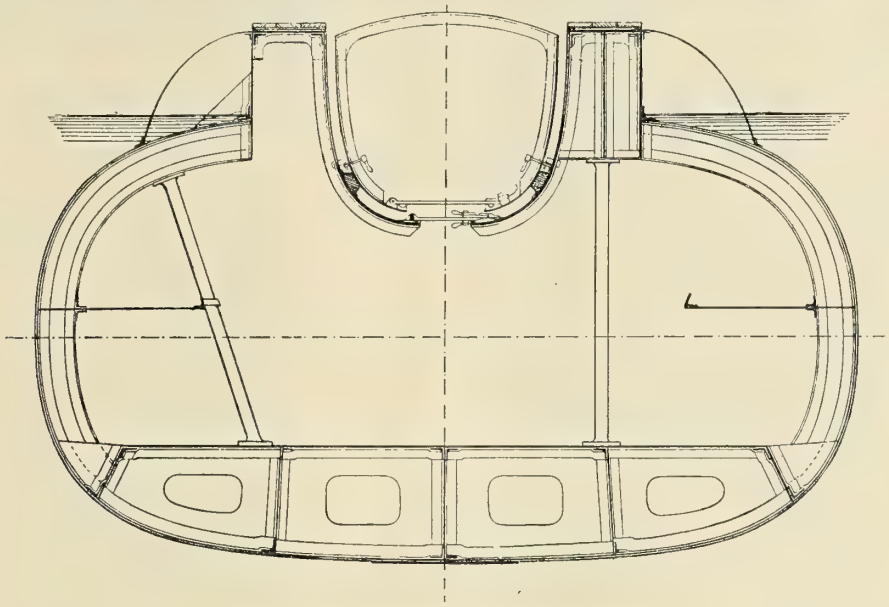


FIG. 52.—MIDSHIP SECTION HOVGAARD'S BOAT.

deck, and in case of danger could be entered from below by means of manholes, and after closing these could be detached from the inside and allowed to float to the surface, similar to the lifeboat on the *Plongeur* of Burgois and Brun. Hovgaard's boat was to be of such strong construction that it could stand a submersion to a depth of 325 ft., but the intention was that only in the case of dire necessity should it be completely submerged. The main idea was that it should be only partially submerged, so that it made a very small target for the enemy's guns. This boat was never built.

CHAPTER XXIII.

Peral's Boat, 1888.—In 1888 the partially submerged boat shown in Fig. 53 was built at the navy yard at Cadiz by the Spanish Navy, according to plans drawn by the naval officer, Isaac Peral. The boat is 72 ft. long, 9 1-2 ft. beam, and has a displacement of 87 tons. The two screw propellers were each driven, the same as in Campbell's boat, by a 30 H. P. motor, which received the current from 480 storage cells. To lower the boat, water is allowed to flow into the water ballast space located amidships, and an electrically driven centrifugal pump was fitted to remove this water. To assist in raising and lowering, two vertical propellers were fitted, similar to those in Nordenfelt's boats, each driven by a 5 H. P. motor. The three above mentioned auxiliary motors were supplied with current from an independent set of 120 storage cells. A torpedo tube and an armored bow completed the equipment of this comparatively simple boat. The report of her trials states that on the first attempt, December 25, 1889, the boat sank 30 ft. and remained below 16 minutes, and 20 minutes in the second attempt. In a trial at Cadiz, May 20, 1890, the boat was submerged so that only the conning tower remained above water. She covered a distance of 45 knots in 8 hours, equalling a rate of speed of only 5 1-2 knots. The report further states that the tower was under water most of the time, due to the heavy sea, a statement with regard to the weather which does not carry much weight when the small size of the conning tower is considered. Among other trials which were reported, a sham attack at night was to be made on the cruiser *Colon*. She was detected, however, when within 30 ft. of the cruiser, but at the same time nothing was said as to whether the crew of the cruiser were on watch or made any special effort in that direction. The reports are all fragmentary, and it can be assumed that if the trials of the boat had been anything near successful, a great deal more concerning them would have been published.

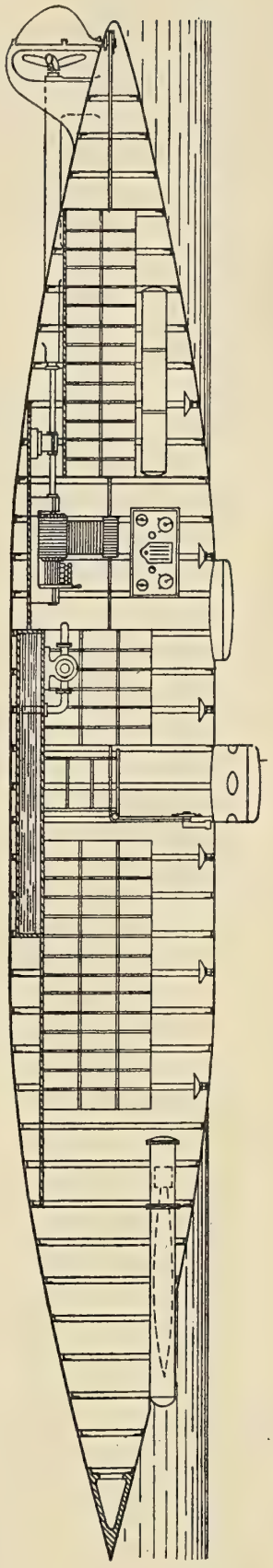
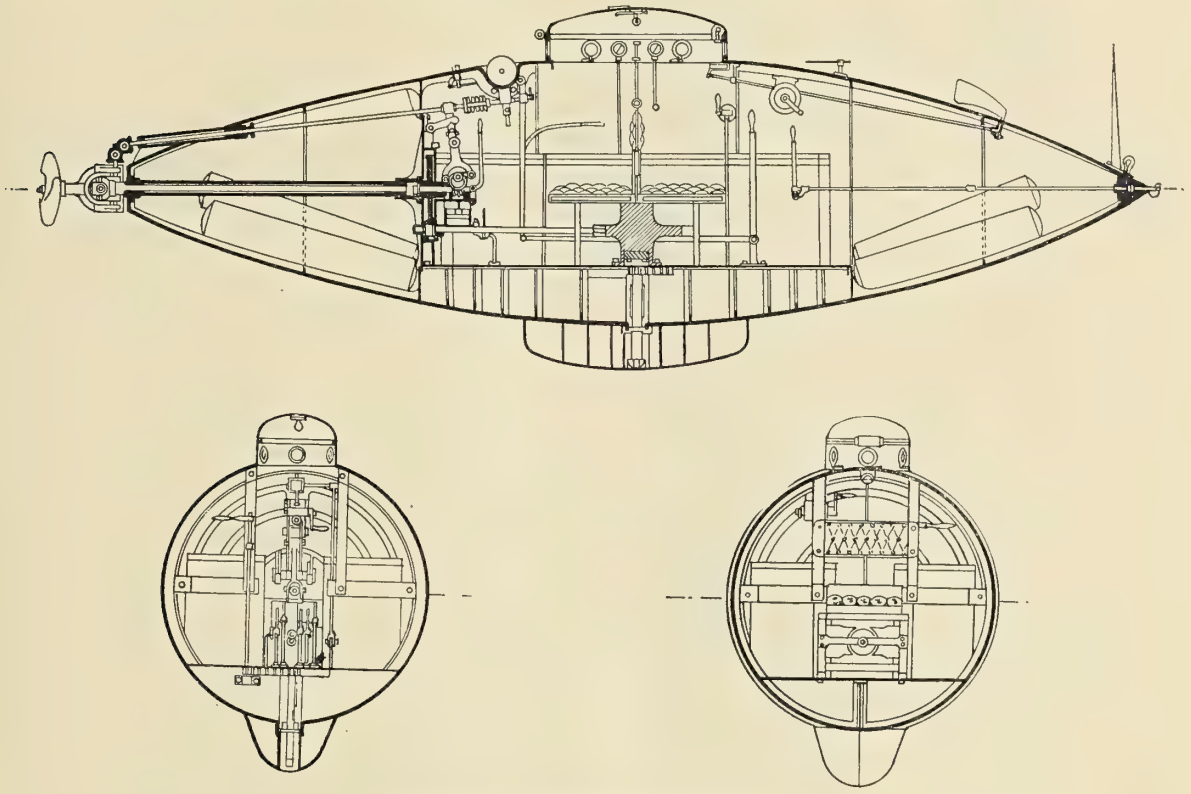


FIG. 53.—PERAL'S BOAT, 1888.

CHAPTER XXIV.

Goubet's Boat, 1889.—On September 12, 1886, the French admiral, Aube, who proposed to carry on warfare at sea with only cruisers and torpedo boats, ordered a partially submerged boat of Goubet in Paris. It was launched at Cherbourg in 1889, and in May and June, 1891, made its official trial trips in the presence of a committee headed by Admiral Gervais. The entire boat (Figs. 54, 55, 56), length 16 ft. 4 in., beam 3 ft. 3 in., depth 5 ft. 10 1-2 in., was cast in bronze in one piece. It was fitted with fin keels either side in the middle, which were intended to increase her fore

and aft stability. The boat was intended for a crew of only two men, who sat back to back in the middle with their heads projecting into the conning tower, through the glass sides of which they were enabled to make observations over the surface of the water. The under side of the seat was a receiver for compressed air for breathing, and the foul air was forced out by means of a pump. All the levers and wheels for operating the boat could be worked from the seats. The screw propeller was driven by a Siemens motor, which received its current from storage batteries, and in case of necessity the propeller could also be driven by hand power. The vertical rod at the bow served as a sight to steer by. The raising and lowering was done by means of water ballast, and the ballast space in the bottom was divided into small chambers connected by small limber holes, so that a change of trim of the boat would not suddenly shift the ballast. A double acting pump was also connected to the water bottom by means of three way cocks, and controlled with a pendulum in such a manner that it would shift the water ballast and automatically control the trim in order to bring her back to the horizontal position whenever disturbed by outside influences. In order to bring the boat quickly to the surface in case of accident, the boat carried a weight at the bottom, which could be easily released by a bayonet lock. Goubet's boat was also intended to be totally submerged, as its duty was to place mines under vessels and after retiring a certain distance to fire them electrically. It was also equipped with a shears, which projected 9 ft forward of the bow, and intended to cut the torpedo nets of anchored vessels. The results of the before mentioned trials did not meet with approbation of the committee, and, therefore, Goubet built a second boat with the same power outfit, and a length of 26 ft. It was cast in bronze in three pieces, which were joined by flanges inside. The middle section had a thickness of 1 in. which tapered to a thickness of 5-8 in. at the ends. A safety weight of 1 1-2 tons was fitted to the bottom, and she carried inside of her hull 7 tons of lead ballast and 2 tons of water ballast. She was fitted with two torpedo tubes 18 in. dia., each with its Whitehead torpedo. She attained a speed of 5 to 6 knots. The trials made in 1899 at Saint-Ouen have been so successful that the Navy Department issued orders to transport the boat to Toulon in order to make further trials.



FIGS. 54, 55 AND 56.—GOUBET'S BOAT, 1889.

S.S. NORTHWESTERN.—The first ocean steamship to be launched in Chicago was launched at the yard of the Chicago Shipbuilding Co. recently for the Northwestern Steamship Co. The boat was launched without any ceremony, and only a flag told the spectators that she was named the *Northwestern*. The vessel is of these dimensions: Length over all, 246 ft.; length on water line, 242 ft.; beam, 42 ft.; depth, 26 1-2 ft. She is to be fitted with triple expansion engines. The *Northwestern* will make a trip to Buffalo in April preliminary to her first European trip.

The Board of Visitors of the U. S. Naval Academy has recommended that the age limit for admission to the Academy be fixed at fifteen to eighteen years.

ACTION OF BILGE KEELS FROM A HYDRODYNAMICAL POINT OF VIEW.—III.*

BY G. H. BRYAN, F.R.S.

III.—EFFECT OF NON-CO-PERIODIC DISTURBANCES.

(9) The effect of wave motions whose period coincides with that of oscillation, whether these be due to the motion of the ship or to external causes, will be to decrease or increase the effective pressure on the bilge keels, according as the currents they produce are in the same or the opposite direction to that in which the ship is rotating. But the effect of wave motions or other independent disturbances of different period will always be to increase the effective pressure on the keels.

For let V be the velocity of the fluid relative to the bilge keel in undisturbed motion, v the added velocity due to the disturbance, k the assumed co-efficient of resistance; and first assume $V > v$. Then, if the two velocities are in the same direction, the resistance is $k(V + v)^2$; while, if they are in opposite directions, the resistance is $k\ (V - v)^2$. Assuming that it is an even chance whether the velocities are the same or in opposite directions, the average resistance is $\frac{1}{2} k \left[(V + v)^2 + (V - v)^2 \right] = k \left[V^2 + v^2 \right]$, and is thus increased by an amount equal to that due to the mean square velocity due to the disturbance. If, however, $V < v$, then, when v is opposed to V, the direction of the effective pressure will be reversed, and the average resistance will be $\frac{1}{2} k \left[(V + v^2) - (V - v)^2 \right] = 2 k V v$, which is more than double the pressure in undisturbed motion, since $v > V$.

In the first case the resistance is increased by a constant amount, and the additional work done in any half-oscillation is proportional to the amplitude of swing. In the second case the resistance is proportional to the velocity. The effects due to non-co-periodic disturbances thus seem likely to give rise to terms proportional to the first power of the amplitude in the curves of extinction. The remarkable magnitude of these terms has been noticed by Sir William White in the aforementioned paper. Among non-co-periodic disturbances must be included a steady current, the effects of which, on a rotating or oscillating lamina, or body with sharp edges, can easily be, and doubtless have been, investigated experimentally. Whether the turbulent motions induced in the water in the neighborhood of the bilge keels by the discontinuous motions set up in previous oscillations can be regarded as fulfilling the condition assumed above, viz., that it is an even chance whether the added velocities are in the same or the opposite direction to the motion of the keels, is another question, on which it is perhaps premature to express an opinion.

IV.—EFFECT OF PRESSURE-VARIATIONS AGAINST THE SIDES OF THE SHIP.

(10) The second cause can be most readily understood by anyone who has noticed how readily a small boat will turn round, even when its rudder is set at right angles to the course in which position the turning moment of the pressure on the rudder itself is practically *nil*. Taking $A\ B$ to represent the rudder in a horizontal plane (Fig. 5), it is seen that the water is heaped up on the side $M\ A$, often, indeed, streaming over the rudder, and depressed on the side $N\ A$. The difference of the pressures on the two sides causes a distribution of thrusts indicated by the arrows by which the boat is turned. Not only is rotation produced, but the boat is given a lateral motion, causing it to turn about a point in front of its center of mass, as is well known in navigation.

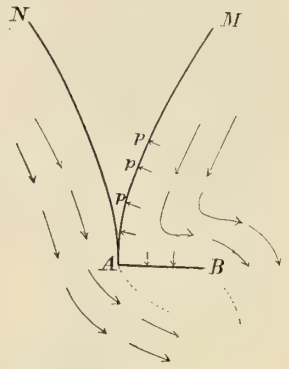


FIG. 5.

Now, let A_0, A_1, A_2, A_3, A_4 (Fig. 6) represent the vertical section of a ship with bilge keels, rolling about O in the direction shown by the circular arrows. The water streaming past the portions A_0, A_1, and thrown off by the bilge keel at A, will produce pressures along the part A_0, A_1 in excess of the pressures along A_1, A_2, the resultants of these excesses of pressure being indicated by the arrow P. Similarly the water streaming past the portions A_2, A_3, and thrown off by the bilge keel at A_3, will produce pressures along A_2, A_3 in excess of those along A_3, A_4, whose resultant is indicated by the arrow Q. Both the systems P and Q have moments about O in the direction tending to check rolling.

When the ship rocks in the opposite direction (Fig. 7), the excesses of pressure will be on the parts A_4, A_3, and A_2, A_1 again opposed to rotation.

If the immersed portion of the ship were of circular section (Fig. 8), the pressures at all points, however their distribution were varied, would always pass through O, the center of the circle, which would be in a fore-and-aft horizontal line through the meta-

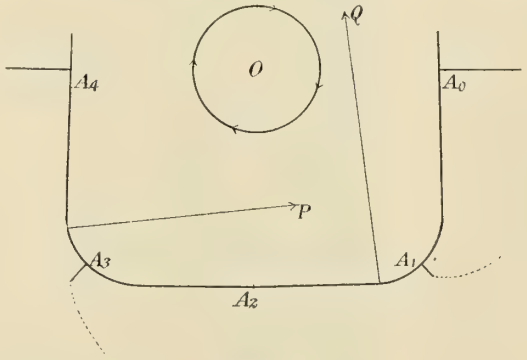


FIG. 6.

*Read before the Institution of Naval Architects, London.

center of the ship. They would thus have no moment affecting the ship's rotation about O. Remembering, too, that rotation about the center of the section produces (in the absence of bilge keels) no stream-line

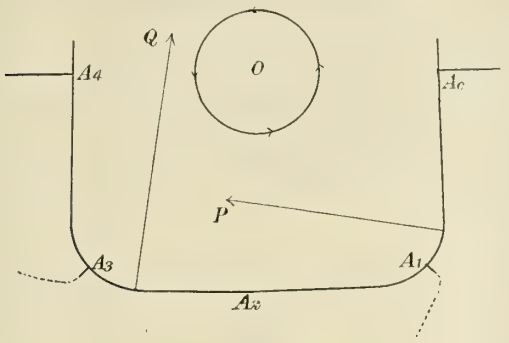


FIG. 7.

motions in the fluid, the agreement between the results obtained by experiments with a paddle and observations of a ship of nearly circular section (represented by the *Sultan*) is easily accounted for. The increased effect only occurs when the ship is of more or less rectangular section.

(11.) In order to explain the dependency of the variations of pressure on discontinuous motions, it

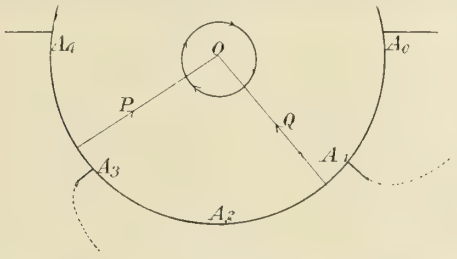


FIG. 8.

will be convenient to consider some simple cases of such motions. The complete investigation of these will be found in mathematical treatises.

Consider the motion of a stream flowing past, and at right angles to, a lamina $D\ B\ C$ (Fig. 9), or, since the motion is symmetrical, we may consider either half separately, and consider the stream flowing past the ⌊-shaped angle $A\ B\ C$ (Fig. 10). Behind the

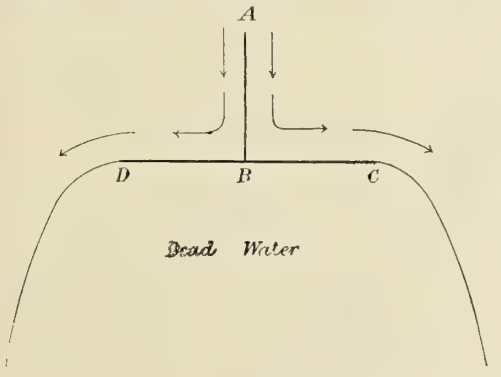


FIG. 9.

lamina $D\ B\ C$ there will be a region of "dead water," which will be separated from the moving liquid by a "surface of discontinuity," or "free stream line" $C\ K$.

Now, in steady motion we have along a stream line the pressure equation: $\frac{P}{\rho} + V + 1\text{-}2\ q^2 = \text{constant}$, where P = pressure, ρ = density, q = velocity, and V

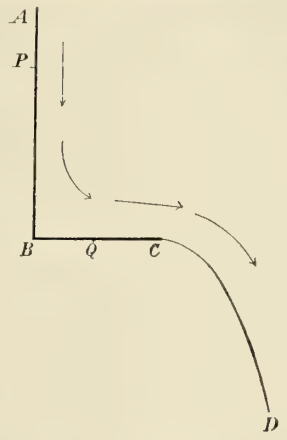


FIG. 10.

is the potential of the outside forces. Since within the region of dead water $\frac{P}{\rho} + V = \text{constant}$, it follows that q^2, and, therefore, the velocity of the fluid, is constant along the surface of discontinuity q = constant. In crossing the surface $C\ K$, the velocity suddenly changes from O to q, but the *pressure* does not change. Omitting the terms depending on V, whose only effect is to produce a statical distribution of pressure, the same as if the whole fluid were at rest, we see that in the whole region of dead water the pressure is the same as along the free stream line $C\ K$, where the velocity is q, and that at any point along $A\ B$ or $B\ C$, where the velocity v is less than q, the pressure is greater than that within the dead water by an amount $1\text{-}2\ (q^2 - v^2)$.

(12.) The determination of the pressure on a lamina in the case represented in Fig. 9 has been made by Kirchhoff, who considered also the case of oblique impact, and the pressure on the lamina itself has been

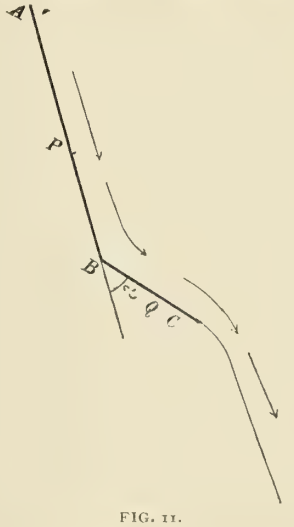


FIG. 11.

found by Lord Rayleigh. The motion past an ⌊ with slanting sides (Fig. 11) has been investigated by Love.

TORPEDO CRAFT (UNITED STATES AND FOREIGN) TYPES AND EMPLOYMENT.—V.*

BY LIEUT. R. H. JACKSON, U. S. N.

The *Talbot* class is an excellent example of arrangement of quarters for boats of this class. The only improvement that could be made would be a double fire room bulkhead and a hatch at the after bulk head. At present the hot air from the fire room bulkhead banks up at the after end of the cabin and remains at 110-120 deg. In cutting a hatch it should be so located that no tables, desks or bunks are close under it, as a moderate amount of rain or spray down the hatch is accepted rather than close it, unless the damage to objects close by demands that it be closed.

The *Morris*, having the most recently designed arrangement of quarters, is very good, the principal drawback being that they are still too much cut up, too hot, and not well ventilated. By moving back her steering engine about 2 ft., and shifting her pantry to the starboard side, a free circulation of air could be obtained from the after state room to the mess room. This would allow he raising of the mess room floor; and lowering somewhat the cabin state-room floor; then by removing the wooden bulkhead between the state room and mess room an excellent, airy room would be obtained. A curtain could be run across the forward end to be used when the bunk is made up. A hooded hatch at the after end of the junior officer's room and a hatch fitted with water tight cover, placed at the forward end of the captain's state room, would add materially to the comfort and make the ventilation nearly perfect. In these boats the petty officers' quarters are abaft the officers' quarters and forward of the forward boiler. There is but one hatch. This ought to be fitted with the square top ventilator described as fitted on the *Talbot*. On some of these boats a sort of temporary hatch hood has been erected similar to this ventilator, to keep out rain; but it is flimsy and cumbersome, and does not work except in port.

There should always be a double bulk head between the fire room and the living quarters, with a lining of asbestos, or else an air space.

A double bulkhead with an air space would materially reduce the temperature in the cabin. This air space could be ventilated by having several small holes near the bottom of the after bulkhead, *i. e.*, the fire room bulk head, and one at the top, the latter to be controlled by a shutter from the cabin so that it could be opened and closed at pleasure. A pipe to be fitted at this upper orifice to run along under the deck and open at a convenient height in the outer casing of the smoke stack. The air in the fire room would then be driven by the blower between the bulkheads, and then between the smoke stack and its casing, thus serving the double purpose of keeping the cabin and the outer stack cool. The amount of pressure thus lost from the fire room could be regulated by the cabin shutter, even to shutting it off entirely when highest pressure was desired in fire room. A few holes could be cut at the base of the outer casing if desired, but in five of our boats the casing is kept cool by draft from fire room blower through small apertures over uptake. These cannot be regulated, however, and help in no wise to cool the cabin.

This scheme would greatly benefit the living spaces in all the boats. An additional device which would add greatly to the comfort of many of the boats would be to have a similar hole in the top of the forward one of the double bulkheads, and a pipe leading from this to the floor of the next compartment, or even under it. In cold weather this would render excellent assistance in heating and ventilating the living quarters. Then, too, at sea in bad weather this would give excellent ventilation.

Crew's Quarters.—The best arrangement yet devised has been attained in the quarters of the *Morris*. The four chief petty officers are forward; the remainder of the crew are arranged in two compartments aft, the entrance to both being through the after conning tower. Practically all of the deck force is in the after one and the engineers force in the other. The conning tower is oblong and contains a long, narrow platform deck, supported by angle irons at the side, but leaving room for ventilation. This gives a nice dry place for the men in bad weather, and still ventilates both compartments. Forward of these two compartments is the galley, with the closets and bath room at one side. The galley should always have an opening into the crew's quarters. In one boat the only opening from the galley was to the deck overhead. No cook could stand it for long at a time, especially at sea, with the side air ports closed. Then, too, with the cook to serve the table, the hoisting of the meals up one hatch and then down again was a great source of inconvenience. By putting a wind sail down the hatch there may always be a tolerable temperature, if there is an opening into the next compartment. The after conning tower being especially valuable for the purpose of ventilation should be large, oblong, and of very light material to keep down the weight.

Deck Fittings and Equipment.—Running around the boat at the height of her deck, or at the turn of the whaleback, should be a heavy wooden guard to take the bumps unavoidably received from the decks, big ships, etc. This saves the bending and dishing of the thin steel side plates. There should be nothing projecting beyond this guard, either above or below. Iron steps riveted on the sides of the boat are an abomination; they catch against the piles alongside of a dock, or cut a hole in a neighboring boat, when entering a slip; they serve no useful purpose, as the boats all have portable sea ladders.

The best deck railing seems to be a soft steel stanchion with three rows of wire, about 1 1-4 in. steel galvanized. The advantages of solid stanchions are that they are neater, stand more bending, can be easily straightened, and are just as light as the hollow pipe stanchions. The stanchions should be held in the sockets by composition pins, kept well coated with black lead and tallow, and unshipped frequently to keep them working easily. Neat slip hooks can be fitted to both ends of the lengths of wire to keep the rail taut.

Boats.—The boats supplied to the *Winslow* type give

*Prize essay read before the U. S. Naval Institute, Annapolis, Md., and copyright, 1900, by R. H. Jackson, U. S. Naval Institute.

excellent service. One is a wooden wherry, nicely finished, ordinarily for the officers' use; and the other a metal boat, slightly larger, fitted as a life boat, with air tanks running the length of the boat on both sides, under the thwarts. These tanks were punctured by accident at first, but a protecting board was run the length of the boat just over them so that heavy objects would not strike the air tanks. The boat withstood many hard knocks during the war and proved very useful. The wooden boat had several holes punched in her at different times, but was repaired with a lead patch each time. Besides its greater durability and its buoyancy (owing to the air tanks) the metal boat possesses the additional advantage of not splintering. This is important, as the torpedo boat would hardly part with her last boat; yet it must remain on deck in close proximity to a gun or a torpedo. If the boats were fitted with spritsail, and a rowlock at the stern which could be utilized for sculling, or for a steering oar, it would add to their convenience, and might in case of abandoning ship be a vital necessity. The folding boats, possessing no good qualities, should be condemned.

As the number and size of the boats supplied are inadequate to carry the entire crew, a life raft must always be devised to carry those unprovided for. If the boat has gratings on her deck these can be utilized. If the boat should go down suddenly there would still be time to loosen and throw overboard gratings that would support the men. If a man also has on an inflated belt he could survive many hours unless the water was too cold. If there should be time for preparation these gratings can be systematically built into a raft, and several empty deck chests placed on them to keep the crew partly out of water.

In boats which are not fitted with gratings the experiment has been tried of having the deck chests watertight, being fitted with tongue and groove lid and rubber gaskets. On the outside a half dozen life lines are fitted to be passed under the men's arms and secured. It was found that a moderate size deck chest would support six men, keeping their heads well out of water.

The life buoys fitted usually consist of three or four circular cork buoys, stopped along the rail about the forward and after towers, where most convenient. They are satisfactory in daylight, but lack a valuable point for night work, since there is no port fire to indicate their position after being thrown overboard. Several years ago a small cylindrical can fitted with calcium phosphide, and similar in a general way to the marker used to indicate the position of a Howell torpedo, was designed and fitted as an attachment on one of the torpedo boats; it worked well, but seems to have been abandoned in the equipment of the later boats. Objects on the surface of the water can only be seen a very short distance from the low deck of a torpedo boat, and the chances of a man overboard at night are slim enough already, without reducing them to a minimum by discarding an apparatus that at least showed his approximate position.

At least two deckchests are a necessity. One of these would be used for alcohol, and turpentine or kerosene, and the other for deck fittings and equipment and deck gear of all sorts. It is usually bulging to bursting, and if room can be found for these chests, and a third one to be fitted on one side for a complete outfit of tools, it would add greatly to the convenience of the boat. In this respect the *Winslow* type was very well equipped. A kerosene can may usually be snugly placed in wake of a conning tower, leaving room for some paint in the alcohol chest. Heavy strap hinges should be fitted to the lids of the chests, with clinched fastenings; the ordinary door hinges with screw fastenings last only a few weeks. These chests should be small enough to go down a hatch so that they can be sent below in clearing ship for action.

An important accessory which has been added to many of the torpedo boats after they were commissioned has been a shelf, usually just forward of the after conning tower, to which a vise could be secured for bench work. As there is a great deal of this work required on board, it is necessary that a comfortable place for the work be found, if possible. The bench can be unshipped and sent below in clearing for action.

A vegetable locker of some sort is needed on deck; a perforated soap box will answer for a small boat; but the boats over 100 tons need a fixed, well-ventilated box placed aft where least in the gangway. The position on the *Winslow* was good; though projections from a dock or vessel would damage it slightly.

Mess and Chart Table.—A very light table with folding legs that could be temporarily placed on deck in good weather often furnishes a refreshing spot to take meals when the quarters below are very hot, or when under way with but one officer on board, and where the navigation would not admit of his absence from deck for a sufficient time to eat a regular meal. By utilizing a signal mast or a torpedo tube as a point of support, a light board with two folding legs will give a very satisfactory mess table. This can be used for a chart table if the weather is fine, but if it is bad the officer will be driven back toward the after tower, or even in that tower. A small folding shelf with a rack alongside, fitted in the after tower, is always useful as a place for log book, charts, books and other aids to navigation, and is often the only dry spot accessible from the deck. At sea in heavy weather all of the navigation is done from this end of the boat. If the charts that are to be employed on the run have all of the courses laid off, the bearings of the lighthouses and principal points, from certain convenient points along the track, and the distances laid off at five mile intervals, the chart can be folded and held in one hand, and the position of the boat approximately located without using the chart table. When accurate position is required it can be plotted on the table in the after conning tower or taken down in the cabin. The heavy- glass covered chart tables placed on some boats are not at all appropriate.

Scuttle Butt.—Boats carrying twenty men and upward should have a properly built scuttle butt, holding 40 or 50 gal. of water placed on deck, fitted with a cover that would keep out the spray. This gives an ample supply on deck where it can get moderately cool and ærated.

Water Tanks.—The difficulties of obtaining a supply of good drinking water are very great. With station

boats under 100 tons the question is not so difficult; the tanks are usually accessible for cleaning, and, as the entire supply of water is taken from a shore station, a boat starting out from a station with her tanks fitted and perfectly clean will have good water till her return, provided the covers have been snugly set up. But as soon as we pass to the class of boats that are sea-keeping, being fitted with a distiller of some description, the question of water becomes a trying one. Only the question of water tanks will be taken up here, as the distiller comes under steam engineering. Tanks are made of copper, tinned inside, or of galvanized iron lined with cement. If these tanks are all accessible when in place, they can be emptied and kept well cleaned when in port. But on account of the desirability of carrying as large a supply of fresh water as possible, some of these tanks are so placed that the living quarters must be abandoned and a week consumed in getting them into an accessible position. The result is that those tanks soon get a deposit of iron rust and dirt that is but little noticed till the boat gets under way, when the water at once takes on a rich brown, and remains that way until the boat is again tied up to the dock. Then the slightest leak in a manhole or hand-hole resulting from replacing the plate after last cleaning, and the sea from the bilge, or spray through the hatch salts up a tank. If to this is added the occasional salting that is given from the evaporator or distiller, it is easily seen that fresh water is a dear article on board. A tank that is not accessible for cleaning by the force on board is of no use for fresh water for drinking or for the boiler.

Steering Engine.—The steering engine installed in the *Porter* class of boats is excellent, and gives perfect control, combined with lightness, durability, and handiness. The shifting from steam to hand is done with facility, and the radiation from the engine is not great. On one of the boats of the *Winslow* type an engine has been fitted that would probably be sufficiently powerful to control the *Yorktown*, while the heat caused the helmsman to faint away. Few men could take a trick at the wheel in rough weather without becoming seasick.

On the *McKenzie* class is fitted what is wittily termed the "Armstrong" system, being a tremendously heavy hand-wheel with cogged gearing which is slow and cumbersome in its action, and probably weighing more than a steam steerer fitted on the *Talbot*.

CRITICISMS ON ORDNANCE.

In general terms our torpedo boats are over armed with torpedoes and under armed with guns.

In the boats represented by the *Talbot* the armament is two central pivot tubes and one 1-pdr. This is about all that the boat can carry. The 1-pdr. should be mounted on the forward tower, instead of the after one, and a 6-mm. machine gun near the boat davits.

In class Q (100-150-ton station boats) the *Cushing* has three short tubes and three 1-pdrs., the *Ericsson* the same, the *Morris* two long tubes and four 1-pdrs., the *Winslow* class three short tubes, four torpedoes and three 1-pdrs. In all of these boats two long torpedoes and three 6-pdrs. would give much greater efficiency.

In the sea-keeping torpedo boats, class P (over 150 tons), two long torpedoes, three 6-pdrs. In the destroyer class two long torpedoes, one 12-pdr., five 6-pdrs. would be a suitable battery.

In the arrangement of battery the most desirable result would seem to be to always place the most powerful gun on the forecastle, the others equally but unsymmetrically along the sides of the boat, especially arranged for bow fire. The gun mount should not sponson or project over the side; but a hinged grating should be fitted so that when swung out the gun captain would have a platform for all round fire that would only be limited by the smokestacks, conning tower, and other guns. It is believed that the following tactical considerations will justify this selection and arrangement of battery.

When the torpedo boat is fulfilling its proper function, and is making a night attack upon a battleship or armored cruiser, the battery would not be manned at all. After the torpedo was adjusted and set to probable angle of fire, two men only would be stationed at each tube, one to fire and the other to change the train if desired, or to fire in case the first man was disabled. All other men would be below deck, except the officer and the man at the wheel. After firing the torpedoes, the boat would rely entirely upon her engines to escape. The flash of the guns from the torpedo boat would only form a target for the rain of projectiles from the ship; good tactics would demand that they be abandoned and save the exposure of the crews.

The next case to be considered is that of a torpedo boat pursuing another torpedo boat, merchant steamer, or other vessel. In this case it is desirable that the battery be placed especially for bow fire, if possible all guns firing directly ahead, so that they can be brought to bear in chase.

In the third case, of a battle between the boat and another boat or vessel of equal or superior size and power. If the vessel is about an equal match a head on attack with the three guns firing would be made, until within a telling range, say 800 or 1,000 yd., when with a sheer of the helm 15 or 20 deg. the whole battery could be brought to bear, and with their greatest efficiency, while the target was greatest, e. g., until the boat passed to a quarter bearing, when an attempt to return under the enemy's quarter would be made. This might end in steering in a circle; if so, the battery could still be employed with full effect. In case the enemy were a superior—a destroyer or gunboat—the first effort would be to escape, the two after guns being employed in an attempt to disable him. Should it appear that escape was improbable, by turning about and charging at his bows and using these three forward guns, the effect of the charge might be very demoralizing, as, of course, the discharge of a torpedo would be anticipated. Just when the torpedo would be discharged would depend upon the maneuvers of the enemy.

NEW LAKE STEAMER LINE.—Press reports announce the formation of a new steamship line on the Great Lakes from Detroit to Buffalo. The company, according to report, is to operate two large sidewheel passenger and freight steamers, to be capable of a high rate of speed.

STEAMSHIP GRECIAN OF THE BOSTON & PHILADELPHIA S.S. CO.'S FLEET.

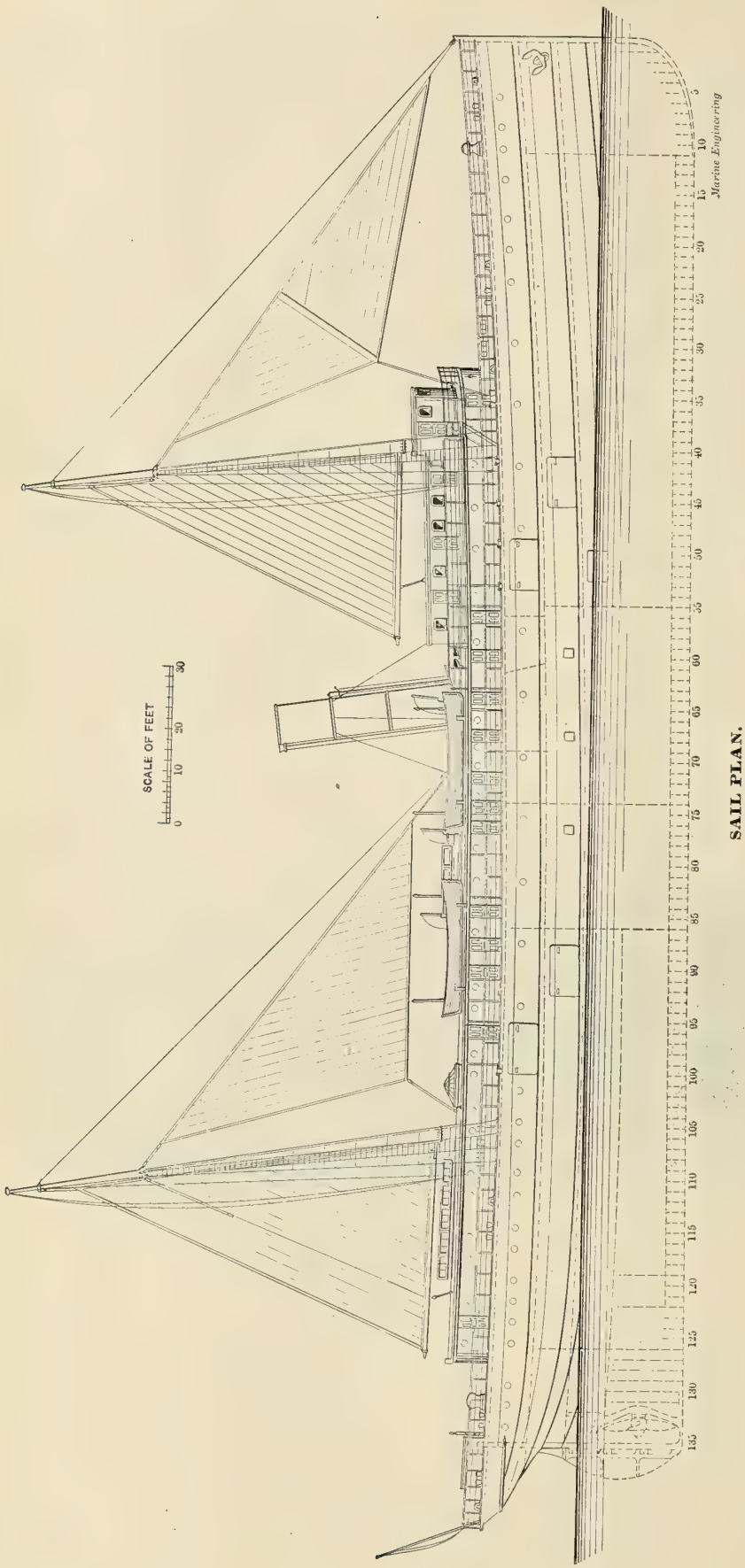
A good example of a modern American coast line steamship is shown in the engravings of the S.S. *Grecian*, which we here publish. This vessel was built not long since at the yard of Harlan & Hollingsworth, Wilmington, Del., for the Boston & Philadelphia S. S. Co.

The *Grecian* is a steel vessel, built to carry about 2,500 tons dead weight, and about 100 passengers, at the rate of 15 1-2 knots, in the coast trade between the ports of Philadelphia and Boston; a tri-weekly service being maintained by the company. The *Grecian* sails from Philadelphia every Wednesday, and from Boston every Saturday, the time of passage being 31 hours, wharf to wharf.

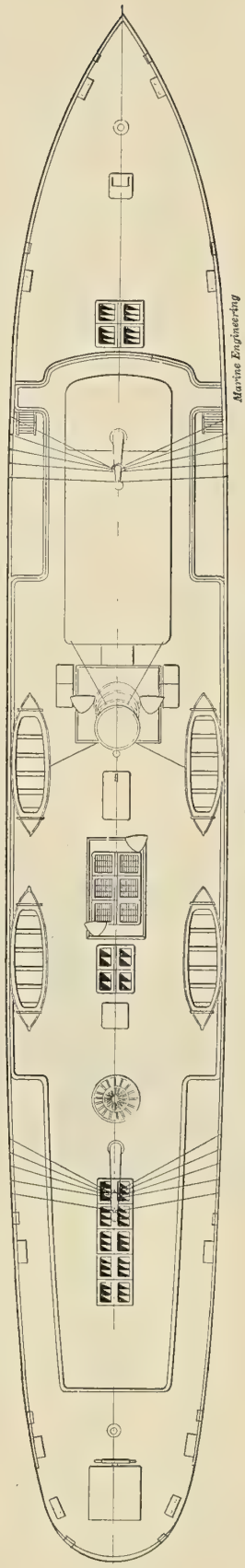
Her dimensions are: Length between perpendiculars, 263 ft.; length over all, 290 ft.; beam moulded, 42 ft.; depth at center to hurricane deck, 36 ft.; gross tonnage, 2,483 tons. By looking at the reproduction of the photograph of the *Grecian* under steam, it will be observed that she is a very shapely ship-shape steamer, having more the appearance of a deep sea vessel than the usual coast liner, which is usually remarkable for an entire absence of anything that pleases the eye. It may be remarked in passing, that the port of Boston can claim ownership of the handsomest vessels in the coasting trade. These may be found in the fleets of the Metropolitan, the Merchants' & Miners' and the Boston & Philadelphia lines.

In the accompanying scale drawings the dimensions of various scantlings employed in this vessel will be found. In addition, some of the important members are: Stem, 11 in. by 2 3-4 in. hammered scrap iron; stern post, 12 in. by 5 3-4 in., and 12 in. by 6 in. below the base; rudder post, 12 in. by 4 3-4 in.; frames, above water bottom, 6 in. by 3 1-2 in. by 3 1-2 in. by 15 lb. channels for 3-5 length amidship, and 6 in. by 3 in. by 15 lb. bulb angles at ends; frames in water bottom, 3 1-2 in. by 3 1-2 in. by 9.9 lb. angles, double under engine foundation; reverse frames, double in engine and boiler space, 3 1-2 in. by 3 1-2 in. by 8 lb.; web frames, 15 in. by 20 lb. web; 24 in. by 3 1-2 in. by 9 lb. angles (12 ft. apart); floors, 42 in. by 18 lb.; 20 1-2 lb. under engine foundation, flanged on top between engine and boiler spaces; frame spacing, 24 in.; bulkheads, 16 lb. plating for lower 3-5th; 12 lb. for upper 2-5th, and stiffeners 5 in. by 3 1-2 in. by 11 1-4 lb. angles, spaced 24 in. centers vertical, and 48 in centers horizontal; shaft alley, 12 1-2 lb. plating. The *Grecian* has three steel decks and hurricane deck of Oregon pine, laid on 7 1-2 in. by 20 lb. bulb angle beams. She has four water-tight bulkheads, extending up through the orlop and lower decks to the main

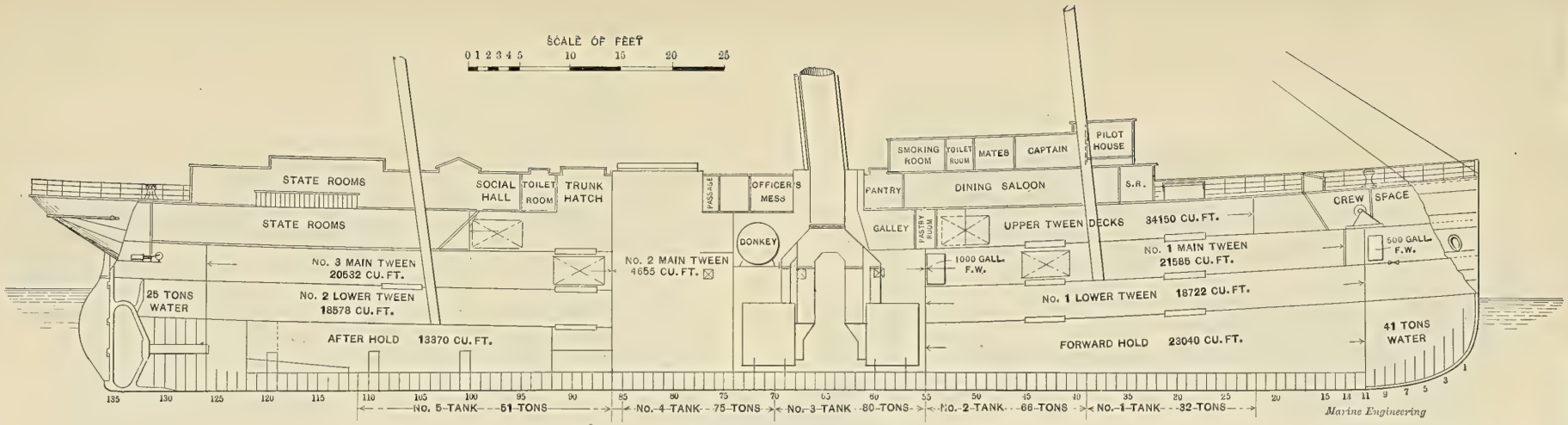
COASTING STEAMSHIP GRECIAN OF THE BOSTON & PHILADELPHIA S.S. CO.



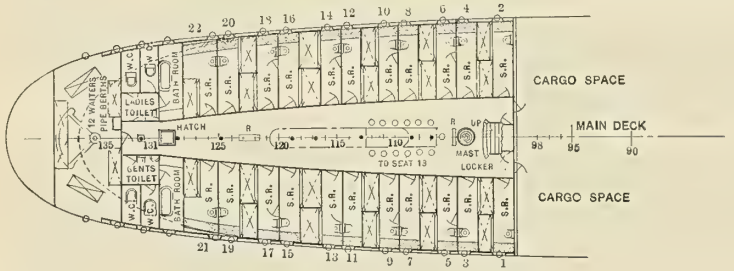
SAIL PLAN.

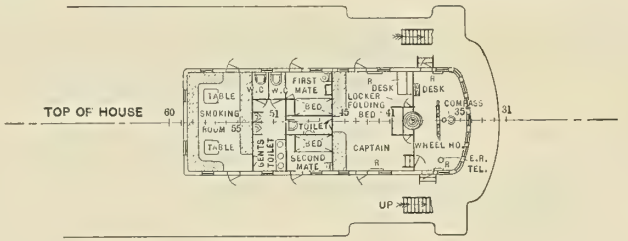


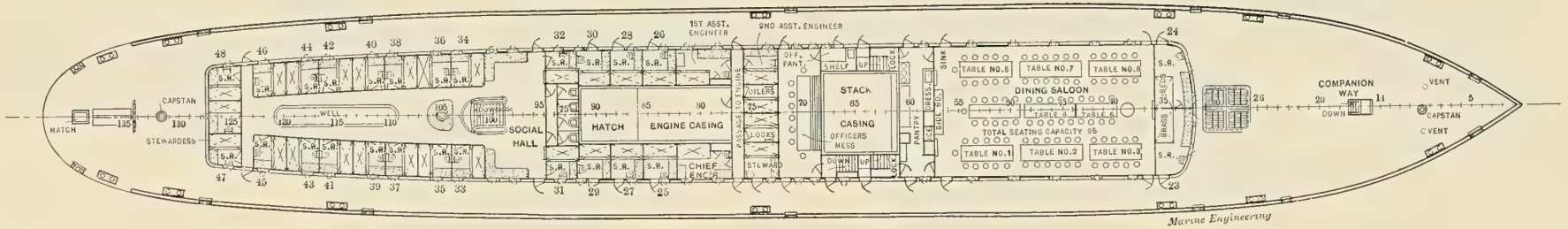
DECK PLAN.



INBOARD PROFILE.

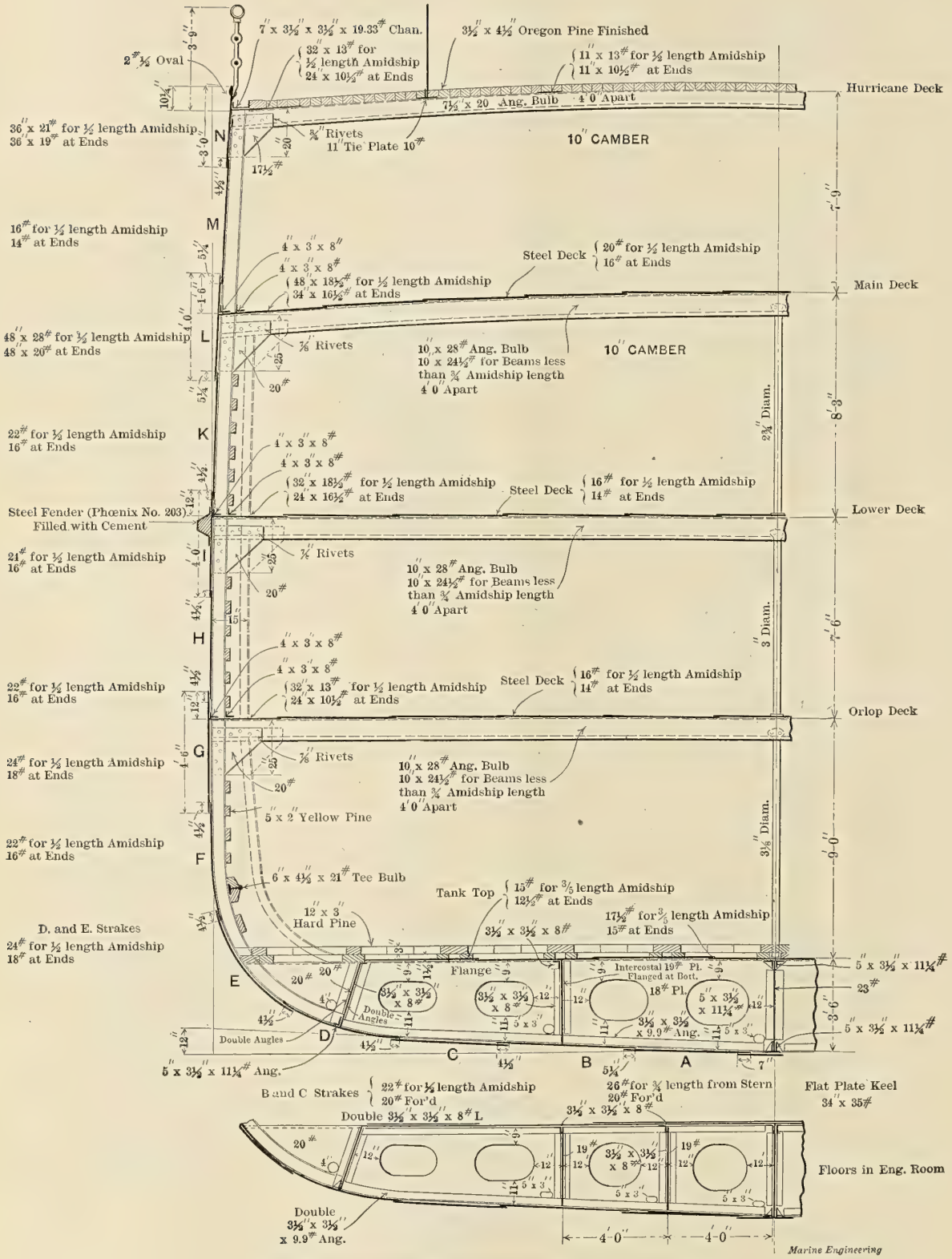




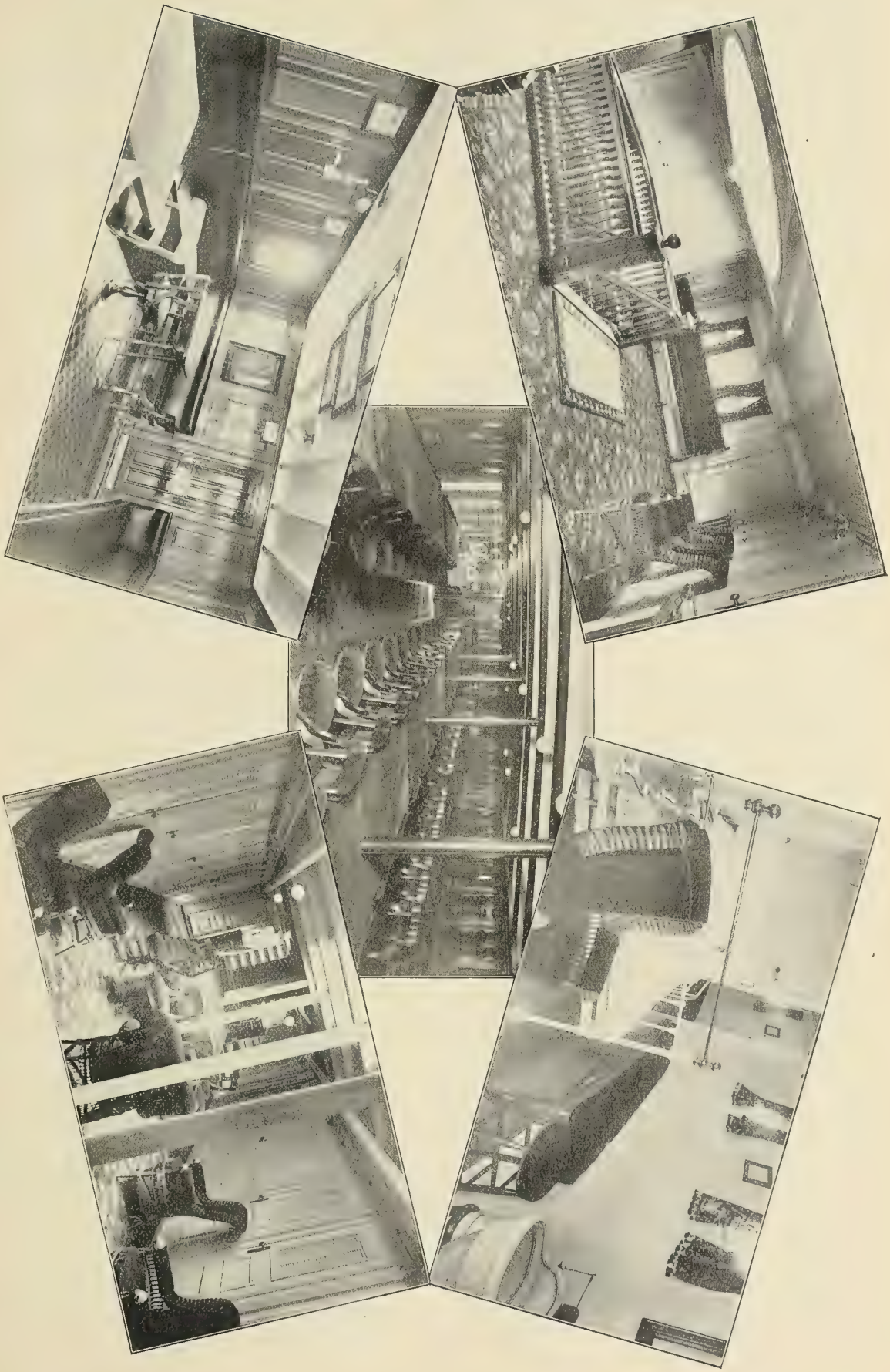


CABIN PLANS.

PLANS OF COAST LINER GRECIAN, BUILT FOR THE BOSTON AND PHILADELPHIA STEAMSHIP CO. BY THE HARLAN & HOLLINGSWORTH CO., WILMINGTON, DEL.



HALF MID-SECTION OF AMERICAN COAST LINER GRECIAN.



INTERIOR PHOTOGRAPHS SHOWING ACCOMMODATIONS FOR PASSENGERS ON THE COAST LINER GRECIAN OF THE BOSTON AND PHILADELPHIA S.S. CO.

deck, and there is an additional bulkhead forward of the after peak bulkhead and extending up to the orlop deck.

The cargo capacity of the *Grecian* is 36,410 cu. ft. in the holds, and 122,877 cu. ft. in the 'tween decks, making a grand total of 159,287 cu. ft. Coal bunker capacity is 293 tons, figuring 42 cu. ft. to a ton. The total water ballast capacity is 370 tons, and fresh water capacity in the forward, midship and engine-room tanks, 2,500 gals.

Passenger accommodations on this vessel are very attractive. There is accommodation for about 100 passengers in the deck-house, and on the main deck, in the after part of the vessel, as shown in the cabin plans. In the forward end of the deck-house on either side is a cabin of large dimensions, fitted with large ports in the front and at the sides. Aft of this the dining saloon occupies the full width of the house, with a capacity for 95 passengers at one sitting. Further aft, and just forward of the boiler casing, is the pantry and serving rooms, with elevator communicating with the galley below on the main deck. In the space between the stack and engine casings are the officers' mess room and quarters for members of the engineers' and stewards' departments. These rooms open out on a'thwartships passage, on which also open the rooms of the chief and first assistant engineers, so that access to the engine room can be had without going outside. There are staterooms abreast of the engine casing and trunk of the after hatch on each side. In the after part of the deck structure is the social hall with cabins along each side and also at the after end of the house, all of these cabins opening into the hall and gallery. Below on the main deck, and reached by a wide staircase, are the remainder of the staterooms, and accommodations for twelve waiters in the tiller-room. In the superstructure over the main saloon comes in succession, the pilot-house, captain's and mates' rooms, officers' toilet room and passengers' smoking room. The latter is a nice airy apartment and commands a fine view at the sides. There are good accommodations for the crew forward on the main deck.

In interior finish white and gold are used in the decoration of the saloon and social hall; paneled quartered oak and leather upholstery are used in the smoking room, and the dining room is finished in mahogany.

As already stated the *Grecian* is a single screw vessel, the propelling engine being of the usual vertical triple-expansion type with cylinders 25 in., 41 1-2 in. and 68 in. dia. and 42 in. stroke. They were designed to turn up about 90 revolutions with 170 lb. boiler steam pressure. The I. H. P. is 2,650. The front columns are forged and the back are of cast iron surmounting the condenser. For the H. P. and I. P. cylinders piston valves are used, and for the L. P. a slide valve, all being worked by the Stevenson link motion. Steel is the material used for the crank shaft, and this is 12 3-4 in. dia. in two sections. The pins measure 12 3-4 in. dia. by 13 in. long. Both air and bilge pumps are worked direct off the main engine, the former having a barrel 24 in. dia. and 21 in. stroke. Cast iron is used for the propeller, which is of the built-up type 15 ft. dia.

There are four single ended cylindrical return tube boilers, each having Morison furnaces and a Bloomsburg circulator. The boilers are 12 ft. dia. and 10 ft. 6 in. long, each having 256 tubes, 2 1-2 in. dia. Ellis & Eaves induced draft is fitted. There is also a donkey boiler of the same type. In the deck department there is a Williamson steam steering engine, four Williamson winches, and two Hyde steam capstans. For lighting the ship two complete generating sets are provided, each with a capacity of 200 incandescent lamps and an 18 in. projector.

SCHEDULE FOR RIVETING S.S. GRECIAN.

Flat plate keel; treble riveted butt straps 1-16 in. thicker than keel plate; butt straps 21 in. broad.

Bilge sheer strakes (D. E & L. strakes) and main deck stringer plate to have treble riveted butt straps 9 lb. heavier than plates they connect for 3-4 length amidship.

Remaining strakes to have treble riveted butt straps 9 lb. heavier than plates they connect for 2-3 length amidship.

Shell plates over 48 in. width to have butt straps 10 lb. heavier than plates they connect.

Shell plating at ends to have double riveted butt straps 2 1-2 lb. heavier than plates they connect.

Inner bottom. Seams single riveted, butts double riveted for plates 15 lb. and above, single riveted for plates less than 15 lb.

Center keelson. Treble riveted double butt straps 17 1-2 lb., thick.

Steel decks single riveted edge laps, double riveted butt straps.

Designs for the vessel and the work of construction were carried out under the supervision of C. W. Wiley, superintending engineer of the company.

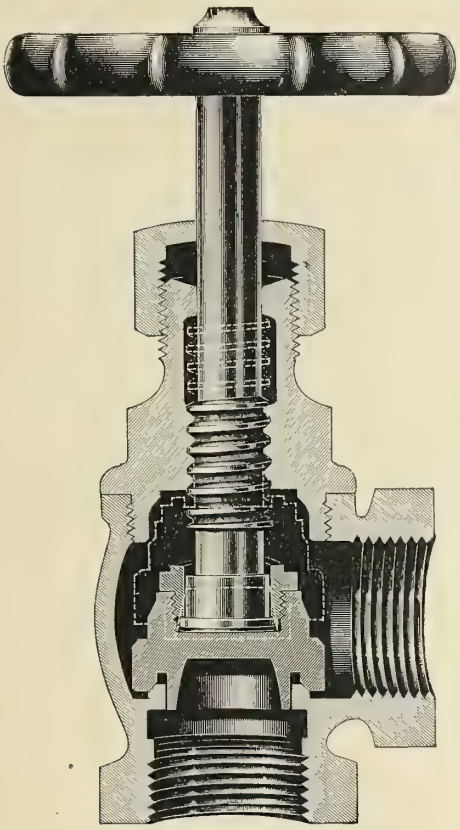
S.Y. Alvina.—The twin screw steam yacht *Alvina* was launched from the yard of Harlan & Hollingsworth, Wilmington, Del., on the morning of January 19. She was christened by Miss Harriett Mary Fletcher, a granddaughter of the owner of the yacht, Charles Fletcher. The *Alvina* is of these dimensions: Length along rail line, 212 ft.; length on load water line, 176 ft.; beam moulded, 25 ft. 11 1-2 in. She will be fitted with triple expansion engines with cylinders 12 in., 21 1-2 inch., and 25 in. and 22 in. stroke. Steam will be supplied by two Scotch boilers, 13 ft. dia. by 10 ft. 6 in. The yacht will be equipped with all modern conveniences. In construction she is fitted with a clipper stem and square stern, with one continuous deck house. There is a forecastle deck with crew's galley, lamp room, laundry, crew's mess, firemen's quarters, and a steam windlass on the forward end of the main deck. Abreast part of the deck house there is a bridge extending to the side of the vessel. There is a chart house and captain's stateroom above the main house. The accommodations for the crew and officers are forward on cabin deck. The accommodations for owner are forward and aft of cabin deck. In the forward end of the house is situated the dining room. In the after part of the house is the library and stateroom. The *Alvina* will be rated at 100 A Lloyds, and will have a speed of 14 knots.

Noah's Ark.—According to the most authentic data Noah's Ark was about 540 ft. in length, 90 ft. beam and 54 ft. deep. It was fitted with three decks, and probably a lower hold. The inside capacity was about 1,300,000 cu. ft. and the tonnage was about 18,000 tons. The proportions were: Length to beam, 6 to 1; length to depth, 10 to 1, and draft, about 27 ft. in fresh water.

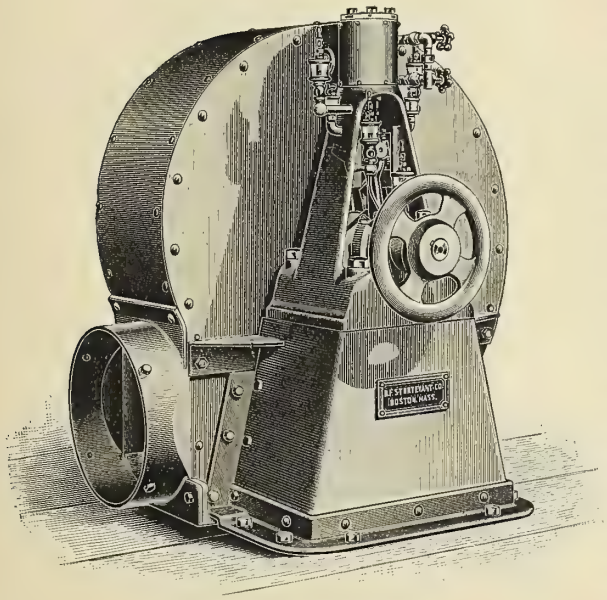
IMPROVED APPARATUS.

Blow Off Valve.

The blow off valve illustrated in the accompanying engraving was designed to overcome the trouble usually met with in valves for this use. It will be observed that the valve seat is on the outside, which prevents sediment lodging at this point. The projection on the under part of the disk prevents any discharge taking place until the seats have become widely separated. This prevents wire drawing. This valve should always be connected from the pressure side. It can be made in either angle or globe patterns, though angle is always furnished unless otherwise ordered. The valve is manufactured by the Crane Co., Chicago, Ill.



CRANE BLOW OFF VALVE.



STURTEVANT STEAM FAN.

Sturtevant Steam Fan.

The B. F. Sturtevant Co., of Boston, Mass., has recently brought out a line of small sizes of steam fans, of which the accompanying illustration gives a good idea. These fans range in total height from 30 in. to 50 in. and weigh from 350 to 950 lb. They are designed for creating pressure of at least one ounce per square inch when the engine is operated under 80 lb. of steam, and for this purpose the engines have to be constructed to run from 650 to 1,250 revolutions per minute, according to the size. Such high speed naturally requires the utmost care in the design and construction of the engine. Of course, certain difficulty arises from the small type of the engine itself, the minimum size of cylinder in this type being 2 1-2 in. dia. by 2 in. stroke. In all cases, however, these engines are equipped with piston valves, with marine type connecting rods, counter balanced crank and complete continuous sight feed oiling arrangements. All moving parts are adjustable for wear, and the cylinder is lagged to reduce condensation. A hand wheel is provided for starting the fan, which latter is of the well known Sturtevant construction, consisting of a steel plate housing with light and carefully balanced steel plate wheel within. This wheel is mounted upon the extended engine shaft and draws the air through the inlet from the farther side. Such fans find especial use in small mechanical draft plants, where they may be operated independently of any other source of power and find particular opportunity for service on board steam yachts and similar small vessels.

THE 1901 RECORD.—The volume for 1901 of the *Record* of American and Foreign Shipping is now being distributed to subscribers. This is the thirty-ninth annual issue of the register and classification of ships published by the American Bureau of Shipping, formerly the American Shipmasters' Association of New York. The *Record* contains full reports and particulars about 17,000 vessels of all classes and nationalities, also rules for the construction and classification of steel, iron and wooden vessels, and rules for the construction and survey of steam machinery and boilers for vessels, regulations for the instalment of electric lighting and power apparatus on ship board, and other information of special importance to persons engaged in shipping. Included in this are such features as lists of addresses of prominent shipbuilders, dry docks, marine railways, engine and boiler builders in the United States, also a list of vessels whose names have been changed, and vessels of compound names indexed by the last name. Also the names and addresses of owners of the vessels classified in the *Record*. The work has been thoroughly revised and brought down to date. The office of publication is 66-70 Beaver street, New York.

MARINE ENGINEERING

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

A BILL was introduced recently in Congress, seeking to amend the law relating to merchant vessels propelled by other than steam or sails, so that all such vessels would become subject to the rules and regulations of the Steamboat Inspection Service of the U. S. Treasury Department. As the law now stands, all vessels under fifteen tons burden engaged in the carriage of freight and passengers, and propelled by gas, fluid, naphtha or electric motors, enjoy the same exemption from inspection as motor boats used for pleasure only. For purposes of reference we reproduce the section of the existing statutes which applies to such vessels, and we have italicized the words which the proposed amendment seeks to strike out, so as to extend the operation of this Act to include all such vessels, no matter what their dimensions may be:

Chapter 61.—An act providing for certain requirements for vessels propelled by gas, fluid, naphtha and electric motors.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that all vessels *of above 15 tons burden,* carrying freight or passengers for hire, propelled by gas, fluid, naphtha or electric motors, shall be and are hereby made subject to all provisions of section 4,426 of the Revised Statutes of the United States, relating to the inspection of hulls and boilers and requiring engineers and pilots; and all vessels so propelled, without regard to tonnage or use, shall be subject to the provisions of section 4,412 of the Revised Statues of the United States, relating to the regulation of steam vessels in passing each other; and to so much of sections 4,233 and 4,234 of the Revised Statutes, relating to lights, fog signals, steering and sailing rules, as the board of supervising inspectors shall, by their regulations, deem applicable and practicable for their safe navigation.

When the present law was up for passage in 1897, it met with much opposition, but it has now been in operation for several years, and, from available information on the subject, it does not appear to have worked any real hardship on the owners or builders of the vessels it applies to. It does not seem to us that there is any good ground for opposing the proposed amendment. The opposition seems to be largely based on an apprehension that this amendment is the thin edge of a wedge which, when driven home, will compel the owners of pleasure motor vessels either to take out engineer's and pilot's certificates themselves, or to hire licensed help. There is much to be said on that question, but it is not before the court in this case, and argument to be pertinent must be confined to the case as presented. We believe that the law, as amended, would be a very good and necessary one, and that any difficulties which might subsequently arise would be occasioned, not by the law itself, but by the manner of its enforcement, which is left entirely in the discretion of the U. S. Inspection Service. The law as it stands is quite arbitrary. Why should the owner of a vessel of "fifteen tons burden" be compelled to obey the license regulations and the owner of a fourteen ton vessel be exempt? It is reasonable that any person who wishes to engage in business as a carrier for hire should satisfy his customers as to his ability to properly control the vessel or vehicle he operates, whether it be an omnibus, an automobile, a motor boat, or steam vessel. The whole tendency nowadays is toward expertness. A passenger or shipper of freight, on a vessel propelled by any form of power motor, can reasonably demand that the crew of the vessel shall know how to operate the propelling machinery with safety, and shall accurately know the dangers of the course over which the vessel runs, and shall also have such a practical knowledge of the Rules of the Road as will reduce the danger of collision to a

minimum. To secure uniformity and fairness in such regulations, Federal control is eminently to be desired. It should, however, be exercised with much discretion, so as not to obstruct transportation or put unnecessary stumbling blocks in the way of those whose endeavor is to accommodate the public and make an honest living at the same time. It is not necessary that the engineer or motor man should be capable of designing a motor, or be an authority in thermodynamics or theoretical electricity. If he has a good practical working knowledge of the handling of inflammable fluids, or the care of batteries, and enough mechanical skill to be able to make necessary adjustments of the apparatus or take care of a simple breakdown, he is quite capable of handling the propelling apparatus of a motor vessel. And as to the navigation end of his business, he need not be a hydrographer or great circle sailor, but sould know the lights, and reefs, and shoals of the course he runs over, and have such knowledge of the Rules of the Road that he can act properly in case of an emergency. We would suppose that builders of boats and their machinery would be relieved to know that competent men had their output in charge; for it stands to reason that, other things being equal, the more skilled the operator the more satisfactory will be the results to all concerned.

ANOTHER interesting bill before Congress, introduced in the Senate, is that which has for its purpose an amendment of existing laws, so as to permit the carriage by steam vessels of any motor vehicle using "gasoline, naphtha, or other dangerous burning fluids." The chief object of this is to permit owners of automobiles to use ferryboats in common with the owners of ordinary vehicles, or those in which the motive power is electricity. There is no existing act which expressly bars out vehicles with hydrocarbon motors, but the general clause relating to the carriage of such fluids as "freight or stores" has hitherto been construed to include motor vehicles. Under this clause such fluids can only be shipped "when securely packed and put up separately" from other articles, and when properly labeled. It is manifest that when this law was passed the carriage of such fluids in motor vehicles had not been considered at all, and so the proposed amendment does not seek to introduce naphtha where it was formerly prohibited, but simply to permit of its carriage in other receptacles than those allowed by the existing law. We do not know of a single reason why the bill should not go through with a rush. It is not likely that any member of Congress would at the opening of the Twentieth Century declare himself so unprogressive and irrational as to oppose the measure, especially when it contains a clause which makes it optional for those in charge of passenger steam vessels to refuse to transport such vehicles when their fuel tanks are full. In the event of the passage of this bill, ferry companies could quiet the fears of any timid soul by insisting that such vehicles be placed at the extreme forward or after ends of their boats, so that, should any fire be started by leakage or negligence, ferry gates could be opened and the offending vehicle quickly dumped over the end.

THE Naval Appropriation bill, reported to the House in Congress January 19, carries $77,016,635, the largest amount ever reported to the House by the Committee on Naval Affairs, though the amount falls considerably below the estimates prepared by the Navy Department. Of the amount contained in the bill more than $9,000,000 is for the purpose of carrying on the work of construction of war vessels authorized in previous bills. New ships for the navy are provided for in the following clause:

> For the purpose of further increasing the naval establishment of the United States the committee recommends that the President be authorized to have built by contract two unsheathed seagoing battleships, carrying the heaviest armor and the most powerful ordnance for vessels of their class, upon a trial displacement of about 14,000 tons each, to have the highest practicable speed and greatest radius of action, and to cost, exclusive of armor and armament, not exceeding $3,850,000 each, and two unsheathed armored cruisers carrying the heaviest armor and most powerful ordnance for vessels of their class, upon a trial displacement of about 14,000 tons each, and to have the highest practicable speed and greatest radius of action, and to cost, exclusive of armor and armament, not exceeding $4,000,000 each. Maximum cost of the vessels herein authorized, exclusive of armor and armament, will be $15,700,000.

A further clause provides that not more than one battleship or cruiser shall be built in any one yard, and that one or two of the ships shall be built on the Pacific Coast. An increase of $2,489,387 is granted for pay with authority to enlist 5,000 seamen and 50 warrant machinists, additional. A clause also provides for the appointment of assistant chiefs of the Bureaus of Construction and Repair, Steam Engineering, Yards and Docks and Equipment.

CORRESPONDENCE DEPARTMENT.

[*Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced, if necessary to illustrate the subject, without cost to the writer.*

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

Safety of Merchant Ships.

Editor of MARINE ENGINEERING:

The two principal considerations of safety of ships are: 1. Strength. 2. Stability.

1. This first can be treated in the direction of strength of the ship as a whole or in the direction of local durability. Strength as a whole has to be provided against longitudinal and transverse bending, of which the former is usually the more formidable. The maximum of the bending stresses is usually at the midship section and by bringing the moment of resistance of this section in relation to an approximated maximum bending moment, a good value of the probable stress in the most strained fibers is obtained as a valuable comparison with other cases. I find a fair maximum bending moment is obtained by taking 1-30 of the product of displacement by the length of the ship and then taking the section through a boiler hatch as being of about the same weakness as a section on a water tight bulkhead.

Local strength has to be provided in the outside plating to prevent buckling under water pressure, in inner bottom framing, decks and their beams and stanchions to support heavy weights and in engine and boiler foundations to distribute inertia strains or heavy weights, etc. Around the stern tubes and propellers of steamers a great deal of local strength and rigidity is required against the influence of moving machinery masses. In the lower forward part of full bodied, flat bottomed cargo carriers great care has to be exercised against damage through pounding in a heavy sea, if driven with less than full immersion. Reinforcements around air ports, cargo and coal ports or scuttles are other instances that require careful design and undivided attention of the naval architect to secure a structure that will wear like the old "one hoss shay"—uniformly all over.

2. The lack of attention to the subject of stability by supervising bodies as well as individual shipbuilders is to me a very deplorable fact, as not too much attention can possibly be given to this subject. The underwriters themselves recognize the importance of this by supporting boards and a staff of experienced men—inspectors—who criticize stability aside from superintending the stowage. This body of inspectors supplement the classification organizations and it seems surprising that these latter bodies are not more anxious to exercise supervision over stability in a scientific and systematic manner. At present the inspectors do little more than to make a crude guess.

Reliable data can be secured at a small cost by heeling experiments. These are simple and easily executed, and give most valuable information. The labor of moving perhaps 10 to 20 1-ton weights of cast iron, mounted on small wheels and fitted with handles, is so small, the whole affair is rigged up so quickly, the inclinations are read with such ease in a few hours for the whole operation, that this heeling experiment deserves the greatest attention by surveyors, underwriters, shipbuilders and shipowners. Every true friend of American shipping interests can do no better than urge these heeling experiments upon owners and underwriters. A body like a classification company, that would systematically classify and publish dozens of these experiments, would convey a direct and lasting benefit to the ship owning and insuring interests, as well as to the shipbuilders for improvement of their future designs. Nearly every ship has a reliable displacement scale on board, which is the only necessary information required for the experiment. With the amount of weight moved and the distance of moving, as well as the inclination measured, all the data for determining the initial stability or metacentric height are obtained.

From the freeboard and the metacentric height a reasonable approximation can be made upon the range of stability under inclination, giving a good insight into all the phases of stability for the particular ship.

THEODORE LUCAS.

U. S. NAVY.—The total number of vessels in the U. S. Navy built and building is 254, divided as follows: First class battleships, 14; first class battleships, sheathed, 3; second class battleship, 1; armored cruisers, 5; armored cruisers, sheathed, 3; armored ram, 1; steel single turret monitors, 4; double turret monitors, 6; iron single turret monitors, 8; protected cruisers, 15; protected cruisers, sheathed, 8; unprotected cruisers, 4; gunboats, 14; light draught gunboats, 3; composite gunboats, 6; training ship (Naval Academy), sheathed, 1; special class, 2; gunboats under 500 tons, 22; torpedo boat destroyers, 16; steel torpedo boats, 35; submarine torpedo boats, 8; wooden torpedo boat, 1; iron cruising vessels, 5; wooden cruising vessels, 7; sailing vessels, wooden, 6; tugs, 39; wooden steam vessels unfit for sea service, 11; wooden sailing vessels unfit for sea service, 6. There are also six auxiliary cruisers, twenty-three converted yachts, sixteen colliers and eleven "special class" vessels.

TANK STEAMER PINNA.—The *Pinna,* one of the four large tank steamers building for the Shell Transport and Trading Co., was launched from the yard of Sir W. G. Armstrong, Whitworth & Co., recently. The *Pinna* is the largest tank steamer ever built, and is of these dimensions: Length over all, 436 ft. 10 in.; length between perpendiculars, 420 ft. 10 in.; extreme breadth, 52 ft.; moulded depth, 33 ft. 9 in. The *Pinna* is intended for the carrying of oil in bulk on her outward journeys and general cargoes on her homeward voyages. Like other steamers owned by the Shell Trading Co., she will be fitted with oil burning arrangements under the boilers. A description of the apparatus used in one of this company's vessels was recently published in these pages.

S.S. NORTHMAN.—The freight steamship *Northman,* the second of the ocean going fleet being built by the Chicago Shipbuilding Co., was launched from the South Chicago yard on January 19 last.

ENGINEERS' DICTIONARY.—XXXIII.

Pillow Block.—A name frequently given to the main crankshaft bearings. See also under *bearing.*

Pinch Bar.—See *pinch wheel.*

Pinch Wheel.—A large cast iron wheel fitted to the crankshaft, usually just aft of the bedplate, and provided with sockets or holes in which the end of a bar called a *pinch bar* may be inserted. Using this bar as a lever on a convenient fulcrum the wheel may be slowly turned around and thus the engine may be moved by hand for setting a valve or prying off the center. This operation is often called "*pinching*" an engine. Naturally the pinch bar is only of use with engines of small or moderate size. Occasionally, however, engines of larger size are provided with a pinch wheel carrying a removable block of metal which may be acted on by a hydraulic jack. In this way, though very slowly, the engine may be moved by hand. In modern practice the turning engine and wheel take the place of the pinch bar and pinch wheel for the occasional moving of the engine when not under steam.

Piston.—That member of the steam engine which receives that direct pressure of the steam and is thereby moved to and fro in the cylinder, thus giving a reciprocating motion which is communicated by the piston rod to the other moving parts. See also under *engine.*

The usual form of marine piston is shown in Fig. 92 and consists of a shell of conical form with a central boss or body for carrying the piston rod, as shown.

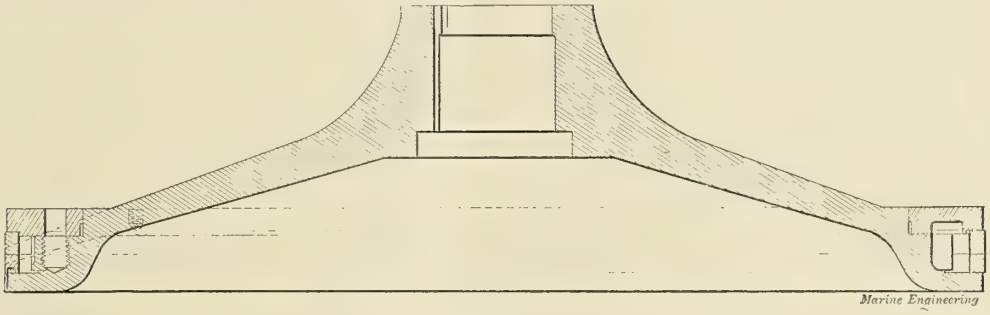

FIG. 92.

Around the outer edge is a thickened ring of metal to provide for the packing rings which are fitted to make a steam tight joint between the piston and cylinder walls. These rings, as shown in Fig. 93, are usually two in number, and are formed of cast iron, turned first to a diameter slightly larger than the bore of the cylinder. They are then cut, as shown in Fig. 93, and enough is taken out so that they may be sprung together sufficiently to allow their entrance into the cylinder bore. In order to prevent leakage through this cut a brass tongue piece is fitted, as shown in Fig. 93, attached to the ring on one side and overlapping the slit as shown.

When the piston is of any considerable size it is customary to aid the natural elasticity of the rings by steel springs of the form shown in Fig. 94. These bear on the bottom of the recess formed in the piston, and on the inner surface of the rings, and thus the latter are forced outward against the surface of the cylinder.

The body of the piston, as shown in Fig. 95, is turned slightly smaller than the diameter of the cylinder, so that it clears the latter, while the rings extend beyond

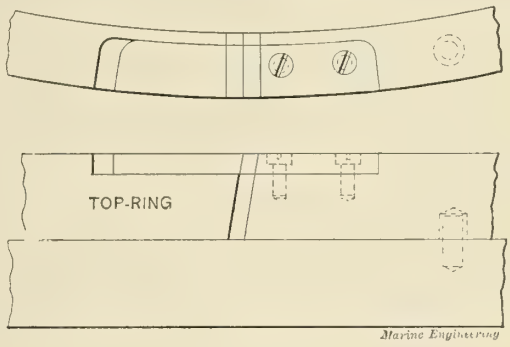

FIG. 93.

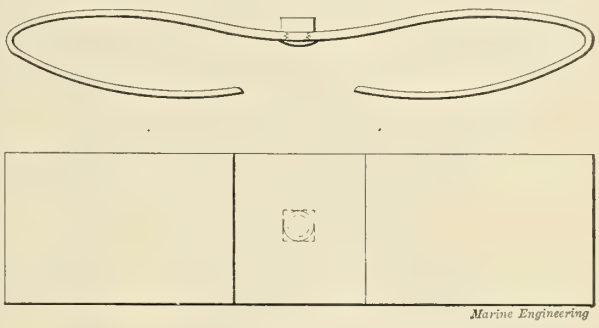

FIG. 94.

and make the joint with the cylinder wall. The rings and springs are fitted between a flange of the piston

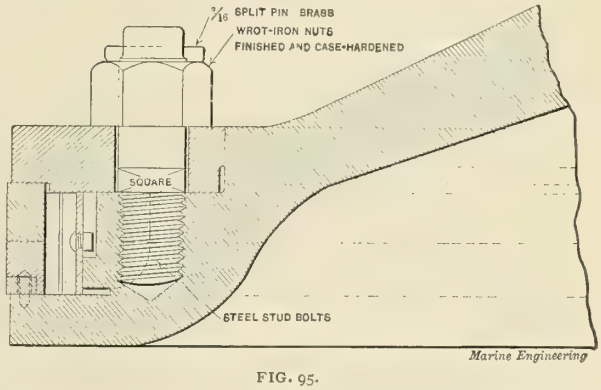

FIG. 95.

body and a plate known as the *follower plate* or *ring*, as shown in the figures. This plate is secured to the

piston by studs and nuts, as shown, and by its removal the rings and springs may be removed for examination or renewal.

Many variations are met with in the details of the form and fitting of pistons, but this description will serve to illustrate the more common or what may be called the standard type of construction.

The materials almost universally employed for pistons, especially of the form shown in Fig. 92, are cast steel for the body and cast iron for the rings.

TECHNICAL PUBLICATIONS.

MARINE ALMANACK 1901. Edited by *Mittheilungen aus dem Gebiete des Seewesens.* Gerold & Co., publishers, Vienna, Austria. Pocket size. Pages 402. With marginal index, blank sheets for notes, and pencil case, and many illustrations. Price, 4 1-2 marks.

This annual publication is prepared under the immediate auspices of the Austrian Department of Marine, and is intended to give in the most condensed form the largest possible amount of information relating to the navies of the world and their armaments. Primarily intended for German speaking peoples, its accuracy, wealth of information and excellence of make up have widely extended its reputation as a reliable and compact source of information on the subjects of which it treats.

Aside from the calendar and some other information of general interest, the subject matter is presented under four heads.

Part I consists of a collection of various tables of weights and measures, with reduction tables for conversion, chiefly between the English and metric systems. Aside from the general value of such handbook information the chief interest of this section for the English speaking public lies in the ready means thus provided for converting into English measures the data given elsewhere in the book in the metric system.

Part II consists of a most convenient and useful condensation of marine international law. The subject is divided into three parts: that relating to peace, that relating to war, and sea-ceremonial.

The subject is well divided and is presented with catch heads for convenience of quick reference. The compiler has succeeded most admirably in presenting a reliable and convenient condensation of the accepted conventions of international law as they bear on maritime questions.

Part III is devoted to tabular data relating to naval ordnance. It covers some 70 pages of matter and gives in detail, and conveniently arranged, the leading particulars of the naval ordnance of all maritime powers.

In Part IV is presented in tabular form the leading characteristics and particulars of the various ships belonging to all naval powers. It may be of interest to note that the number of ships thus described in greater or less detail is about 1,100. This covers about 150 pages and is provided with marginal index for convenience of reference. The tabular matter is then followed by about 130 pages of line drawings, showing the general appearance of the leading and representative ships of the various navies, together with diagrammatic representations of the character and distribution of the armor and main battery. Following this is an alphabetical list of the names of all ships described.

This little almanac, or annual publication, has gained an assured place in naval literature, and justly deserves its high reputation as an authoritative collection of data relating to the ships and naval ordnance of all naval powers. It may be most cordially recommended to all who are interested in having at hand information on these subjects.

SLIDE VALVE GEARS. By Frederick A. Halsey. Sixth Edition, Revised and Enlarged. D. Van Nostrand Co., New York. Size, 5 by 7 1-2. Pages, 203. With 109 diagrams. Cloth, $1.50.

This book has become so well known to the engineering public that reference here may be made chiefly to those features which have been added since the earlier editions. The first 130 pages of the present edition contain the entire subject matter of the early editions, and in the same form, with the addition of two pages of text and two full page diagrams relating to exhaust lap. In Part IV is found about 65 pages of new matter relating to the slide valve with the Stephenson link motion. The gear is first discussed in its simplest or ideal form and omitting the irregularities due to the structural features of the actual link.

The further development of the subject is based upon the structural features commonly met with in locomotive practice.

The chief sources of irregularity, as pointed out and discussed, are the offset of the excentric rod pins back of the link arc, the angular vibration of the excentric rods, the angular vibration of the connecting rod, and the location of the hanger stud. The chief point here made is that to a certain extent the effects due to the connecting rod and the excentric rods compensate that due to the location of the pins, but that such compensation is incomplete and that to complete it as far as may be the hanger stud is set back of the link arc by an amount usually determined by trial.

In the usual form of marine double bar link the irregularity due to the location of the excentric rod pins off the center line of the link does not exist, so that there remains that due to the obliquity of the two sets of rods and to the location of the hanger stud. This is usually of such amount that even if desired complete equalization of events between the two ends of the cylinder can scarcely be obtained by any practicable shift in the location of the stud.

In reference to the book as a whole it is remembered that the Bilgram form of valve diagram is used throughout for purposes of discussion and design. This diagram has special advantages, particularly for design, and the author has made excellent use of it in illustrating and discussing the various problems connected with valves and valve gears.

The book is clearly written and well illustrated, and is justly held in high estimation as a clear and simple treatment of the problems which are usually met with in the design of the more common forms of slide valve gears.

SCH. GEORGE C. THOMAS.—The four masted schooner *George C. Thomas* was launched at the yard of McKay & Dix, Bucksport, Me., recently.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—I am building a sectional water tube boiler and would like to use kerosene oil for fuel. My boiler is 3 ft. by 4 ft. by 5 ft., and I have 12 sq. ft. of grate surface. I would like to know the best arrangement for using oil for fuel?

Also how far below the tubes should the burners be placed. Would it require as much grate surface as with coal? How is the economy with oil fuel as compared with coal? How about the difference between crude and refined oil? P. T. P.

A.—Space does not permit of a detailed description of the apparatus and methods suitable for the use of oil as fuel, but the following points may be mentioned.

Oil cannot be successfully used as a fuel without a change of form which shall admit of a ready and intimate mingling of the oil with the air required for its combustion.

In some systems the oil is introduced into the furnace as a fine spray formed either by air or steam under pressure. Where the spray is formed by steam, air is also usually introduced at the burner, and also in some cases entrained through the furnace door or through special channels. Thus in any case the spray as delivered into the furnace consists of finely divided oil particles closely mingled with air ready to give up its oxygen for maintaining the combustion. In other systems the oil is vaporized before admission and burned directly as such, while in still others a combination of the spray and vaporization methods is used.

Where steam is used as the atomizing agent, it is introduced as a jet into or near the oil as it flows to the burner. At the same time provision must be made for the entrance of the air required for combustion. The use of steam for spraying the oil is expensive in its use of fresh water, using sometimes from 5 to 6 per cent of the total steam formed.

The use of air under pressure to form the spray requires a separate air compressing plant, and is therefore not so available for small craft, though this method gives perhaps the best results from the engineering standpoint. In the most modern methods air previously heated, as well as superheated steam, have been used to form the spray, the action of the heated air or steam being to more or less completely vaporize the liquid before it reaches the furnace, or at least the location of active combustion.

It has been found beneficial to have in the furnace a certain amount of fire brick, lying on the bars or built up in the shape of walls or screens, and against which the blast of burning gas may be directed. This brick work becomes white hot, and thus helps to maintain the temperature of the furnace at the necessary point, and tends also to steady the temperature in case of fluctuations in the oil supply. The brick also furnishes a surface on which the force of the blast of burning gas may be directed, thus saving the material of the furnace,

The most common and most serious difficulty with oil fuel burners, especially of the spray type, is found in their clogging and more or less complete obstruction, either with impurities in the oil, or with a charred crust formed as a result of the heat in the furnace.

Regarding the distance from the lower tubes to the burners, it may be said that while this would depend somewhat upon the style of burner employed, they should be placed not far from the location of the actual fire in the usual arrangement for burning coal, or from 10 to 12 or 15 i 1. below the tubes. This will give suitable volume above them for the combustion of the gases before they enter and pass up among the tubes and over the heating surface of the boiler.

In regard to the grate area required, it may be said that this feature has little to do directly with the combustion of the oil, except perhaps as a convenient base for supporting the brick work referred to above. The real question is in regard to the heating surface required, and in this respect it would hardly be wise to allow less than with the usual arrangements for coal fuel. With a given amount of heating surface required, and a given type of boiler, the size is practically determined independent of the question of grate area in itself.

Regarding the economy of oil compared with coal, it may be said that with equal economy of combustion 1 lb. of oil fuel should furnish from 1 2-3 to 1 3-4 times as much steam as 1 lb. of coal. Their relative evaporative powers are thus often taken as 7 to 4. It must not be forgotten, however, that this ratio relates to the same quantity of fuel. The oil fuel will cost considerably more per pound than the coal, and, in fact, with present prices it may be expected that one dollar's worth of coal will furnish more steam than one dollar's worth of oil fuel.

Regarding the choice of crude or refined oil, it may be said that there is but slight differenee in their evaporative powers, while the crude oil is, of course, cheaper than the refined. On the other hand, the crude oil is more difficult to handle than the refined, and gives more trouble in the burners, besides giving more odor and more danger of generating gases which may make explosive mixtures with air. For small boats, therefore, where the fuel expense is not large, refined oil might be found more satisfactory; while for large vessels, on a commercial basis, use must be made of crude oil, or of the residue after a certain degree of refining.

Q.—I have a steam launch 36 ft. by 6 ft. 8 in. by 3 ft. 6 in. Engine 6 in. by 7 in. and boiler, water tube, 3 ft. by 4 ft. I am allowed 200 lb. steam pressure and the engine turns a 32 in. by 56 in. pitch wheel 350 revolutions per minute or thereabouts. I want a large boat about 48 ft. by 8 ft by 3 ft. 6 in., and would like to know if the machinery is strong enough for the larger boat? Also please say what you think of an electric launch. C. W. S.

A —Your larger boat if of about the same fineness of form as the smaller one would have about 60 per cent more displacement. If then fitted with a new propeller, so proportioned as to enable you to develop your full power, or the same power as at present, you should expect a falling off in speed of from 10 to 12 per cent. If you should try to use the same wheel you would not develop the full power, and the falling off in speed would be still more marked.

Regarding electric launches, the following are the chief points for and against, briefly stated and without discussion.

The number of men required to run the launch is less. The storage batteries require no feeding, and the motor and shafting require little attention. The services of the engineer may, therefore, be dispensed with, and it will be sufficient for all ordinary care if someone has the electrical knowledge necessary to the proper manipulation of the machinery when in use. Again the motor may be placed under direct control from the pilot house or cockpit. The various grades of power as well as the reversal are obtained through the various groupings of switches and resistances forming the controller. The combinations are effected by a lever placed within convenient reach of the man at the wheel, and thus the entire control of the boat, both the steering and the application of the power, are placed within the immediate control of one man.

Again the energy in a storage battery, when charged, is instantaneously available. There is no delay whatever corresponding to that necessary for getting up steam. The expense also continues only as long as the current is on and the boat under way. Further the power admits of rapid and extreme variations, up to two or three times the normal power for a few minutes at a time. This large reserve of power instantly available may be of great value, especially for boats which have to navigate crowded harbors or make frequent landings. The internal space occupied is also less for the electric motor than for other forms of motor, and furthermore it may frequently be put under the inner flooring and, therefore, entirely out of the way so far as valuable space is concerned. In the same way the cells of the battery, while bulky in the aggregate, may usually by stored under the seats and in space not otherwise valuable, thus leaving practically the whole internal space available for passengers.

Other advantages are the absence of smoke, smoke-pipe, noise and vibration. The last two are relative, but the electric motor is practically noiseless, and with a properly balanced propellor the motion is almost perfectly smooth and free from tremor or vibration.

On tbe other hand, as minor disadvantages, mention may be made of the absence of steam to operate a steam siphon for the bilge, or a steam whistle for signal purposes. Substitutes for these may be found, however, so that the points are not serious.

A further disadvantage is in the restriction of the boat to the locality where a charging current for the batteries is available.

Again a single charge at ordinary running will only last for from

six to ten hours; so that frequent renewals of energy in the battery are necessary.

The most serious limitation to the use of storage batteries and motors, however, comes from the excessive weight of the equipment. This is so great that where very high speed is required the electric equipment cannot compete with the steam boiler and engine. Also where long endurance is desired, as for example, capacity to run for periods longer than 10 or 12 hours, the same limitation comes in. A further disadvantage is also found in the much greater cost of the electric equipment, as compared with that for the same power in other forms.

It will be thus seen that for many purposes the electric launch is most admirably adapted, while for others it is entirely out of the question. Judgment must, of course, be used in any given case regarding its suitability or otherwise.

Q.—I would like some information regarding the method of figuring the tonnage of a vessel.

G. E. B.

A.—*Tonnage* refers to the internal capacity or volume of a ship.

Gross tonnage is the entire internal capacity measured according to certain rules as specified in the navigation laws of the United States, and according to the size and type of vessel.

Net tonnage is the remainder after having taken from the gross tonnage certain allowances for crew space, engine and boiler rooms, shaft alley, etc.

The net tonnage is supposed to represent the earning capacity of the ship, and it is therefore made the basis for port and navigation charges.

The detailed rules for computing tonnage are somewhat complicated and could hardly be explained in detail in the space here available. They will be found, however, in the navigation laws of the United States, or under the Revised Statutes, Chap. I, Title XLVIII, Sections 4,150 to 4,153 and Chap. 398.

If you wish to ascertain about what the tonnage of your boat will be, your best plan would be to submit your drawings and plans to the nearest local inspector of the United States Steamboat Inspection Service.

Displacement, which is often confused with tonnage, is the weight of the water which the ship displaces, or, what is the same thing, the weight of the ship itself and everything on board. Hence the displacement varies from day to day, or from one voyage to another, according to the cargo, coal, stores, etc., on board, while tonnage, being determined by the type and internal dimensions of the ship, is constant.

Q.—(1) If a pilot on western rivers holds a first class license can he take charge of river steamers of any tonnage without a master license?

(2) Can a first class mechanic and stationary engineer after one year's experience in the engine room of river steamers make application for a chief engineer's license and receive the same or must he start on an assistant's license?

(3) Are all licensed officers on river steamers restricted to tonnage—that is should their license cover a tonnage large enough to take in all river steamers, or must it cover the tonnage of a particular vessel?

E. A. F.

A.—(1) It is impossible to answer this definitely, as first-class licenses may be qualified, either as to tonnage, or as applicable only to certain parts of a river. Pilots do not act as masters without a master's license; a master, however, may have a joint license as master and pilot.

(2) He would receive a license only as second-class or assistant.

(3) Inspectors have power to exercise discretion in limiting tonnage or granting an unrestricted license.

Q.—I would like to have the formula for finding the size of crank shafts for stern wheel boats. G. H. W.

A.—The shaft for a stern wheel is usually provided with two cranks at right angles. In such case the following formula may be used for finding the diameter of the shaft.

$$d^3 = \frac{I.\ H.\ P.}{N} \times C$$

Where d is the diameter in inches, $I.\ H.\ P.$ is the total indicated horse power of the two engines, N is the number of revolutions per minute, and C is a factor which for steel may be taken about 55 or 60, and for wrought iron about 65 or 70.

Thus for illustration,

$$I.\ H.\ P. = 200$$
$$N = 40$$

Then $d^3 = 200 \times 60 \div 40 = 300$, whence $d = 6.7$ or say 6 3-4 in.

Q.—Please give me the number of square feet of heating and grate surface for a boiler large enough to supply steam for a fore and aft compound engine 12 in. and 24 in. by 18 in. The engine to make 165 revolutions with 150 lb. steam, surface condensing. I figure an upright boiler 78 in. dia. and 10 ft. high, with 360 2 in. tubes 6 ft. long and 28 1-2 ft. of grate surface.

J. A. F.

A.—The question of a suitable size of boiler for your engine depends very much on how hard you may wish to force the boiler. For fairly comfortable conditions, however, your boiler would seem a little small. If you carry a full 150 lb. gauge pressure on your boiler and turn your engine up to 165 revolutions, and if the engine is well designed and has ports and passages of suitable area, you should develop not far from 325 to 350 I. H. P.

At the lower figure you would have to burn probably not less than from 650 to 700 lb. of coal per hour, and with moderately good draft this would require from 30 to 40 sq. ft. of grate surface, with a corresponding amount of heating surface, say 1,000 to 1,200 sq. ft.

For use on a boat the upright boiler to which you refer is hardly to be recommended, especially in such large sizes. You would probably do better to fit a two-furnace Scotch boiler with 35 to 40 sq. ft. of grate surface and about 1,200 sq. ft. of heating surface, or else some approved type of water-tube boiler with not far from the same areas of grate and heating surface.

Q.—We have a steamer 40 ft. long, 25 ft. beam and 9 ft. draft aft and 3 ft. forward. It is fitted with a compound condensing engine 12 in. and 26 in. by 12 in. We carry 150 lb. steam on the boiler and the wheel is 6 ft. dia. and 9 ft. pitch. We would like an opinion as to whether the engine is large enough and also what horse power we can expect? J. M. C.

A.—The data which you send is so incomplete that it is impossible to do more than guess at the remaining conditions and base the answer upon such suppositions.

If the mean draft is about 6 ft. and the ship is of fairly full form the displacement will be about 330 tons. If again your wheel is well proportioned, and your cut off in the high pressure cylinder a little later than half stroke, then we might expect results somewhat as follows:

Speed from	10 to 11 knots.
Revolutions	160 to 180
I H. P.	240 to 270

It would seem probable that the slip of your propeller would be very high, and that you would do better with a wheel of the same pitch but greater diameter, say 7 ft. dia by 9 ft. pitch.

A "Works Management Number" has been issued by the *Engineering Magazine* which for elaborateness and practical utility is the best thing of the sort ever published. It contains nearly 400 reading pages and an abundance of pictorial illustrations. Among the subjects treated are: "Methods of the World's Foremost Industrial Managers," "Great Workshops of the World," "Uses and Abuses of Organization Among Employers and Employees," "Relation of the Steam Engine to Modern Economic Production," etc. Aside from its technical value the issue as an achievement in publication is remarkable.

A beautifully illustrated description of the new Cunarder *Saxonia* is contained in the December issue of *Ireland Illustrated*. This new publication is edited by George M. Roche, Cambridge House, Montpelier Hill, Dublin. It is issued monthly at the low price of 6 pence a copy.